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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

SPECIAL NOTICE TO MEMBERS
(INSIDE FRONT COVER)

ASTYLIS PHLOX

GLANDS AND DEVELOPMENT

MEALY ENDOSPERM IN MAIZE

THE PRIMROSES OF SPANDERSWOUD

ANCESTOR OF THE CACTUS DAHLIAS

EUGENICS IN GERMANY

VARIATION IN PECANS

STERILITY IN LILIES

PE-TSAI CABBAGE

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AMERICAN·GENETIC·ASSOCIATION
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Volume XIII, Number 8 August-December, 1922

Date of Issue of this Number, April 25, 1923

SPECIAL NOTICE TO MEMBERS

A new ruling by the Postoffice Department requires that the Journal of Heredity be issued on time hereafter, under penalty of being no longer entitled to second class mailing priviledges. At a special meeting of the Council of the Association it was, therefore, decided that the best course open to us is to close the present volume with this number, designating it August to December, 1922, while the next number will be Number 1 of Volume XIV, January-April, 1923. The May issue will appear on time, and Volume XIV will contain nine numbers.

In order that members will not lose by this change all dues will be set ahead six months, so that memberships which ordinarily would expire with the publication of the January issue will not fall due until the July number appears.

The Council regrets exceedingly that it will be impossible to carry out our program of making up the numbers we are behind, but since the loss of second class mailing priviledges would necessitate discontinuing the Journal immediately, it is evident that drastic action has been necessary.

The

Journal of Heredity

VOL. XIII, No. 8 AUGUST-DECEMBER, 1922

CONTENTS

ASTYLIS PHLOX.....JAMES P. KELLY 339
AN HISTORIC SPOT FOR STUDENTS OF GENETICS
.....J. C. TH. UPHOF 343
HYBRIDS AND MUTATIONS OF CAMPANULA..... 345
GLANDS AND PERSONALITY (A Review)..... 346
THE FACTS OF SOCIAL HYGIENE (A Review)..... 348
DUCTLESS GLANDS AND DEVELOPMENT
.....JULIAN HUXLEY 349
HERITABLE CHARACTERS OF MAIZE—MEALY
ENDOSPERM.....P. C. MANGELSDORF 359
THE FREUDIAN OBSESSION (A Review)..... 365
BOOKS RECEIVED..... 365
VARIATIONS IN PECANS.....J. C. BRISON 367
THE DOCTRINES OF SIDIS (A Review)..... 368
STERILITY IN LILIES.....A. B. STOUT 369
SELF-STERILITY IN CHINESE CABBAGE
.....YOICHI KAKIZAKI 374
DISCOVERY OF THE ANCESTRAL FORM OF DAHLIA
JAUREZII.....W. E. SAFFORD 377
POPULAR GERMAN EUGENICS (A Review)..... 381
A PSYCHOLOGICAL HISTORY OF MANKIND (A
Review) 381
EUGENICS IN GERMANY..... 382
THE PHYSIOLOGY OF PSYCHOLOGY (A Review)..... 384

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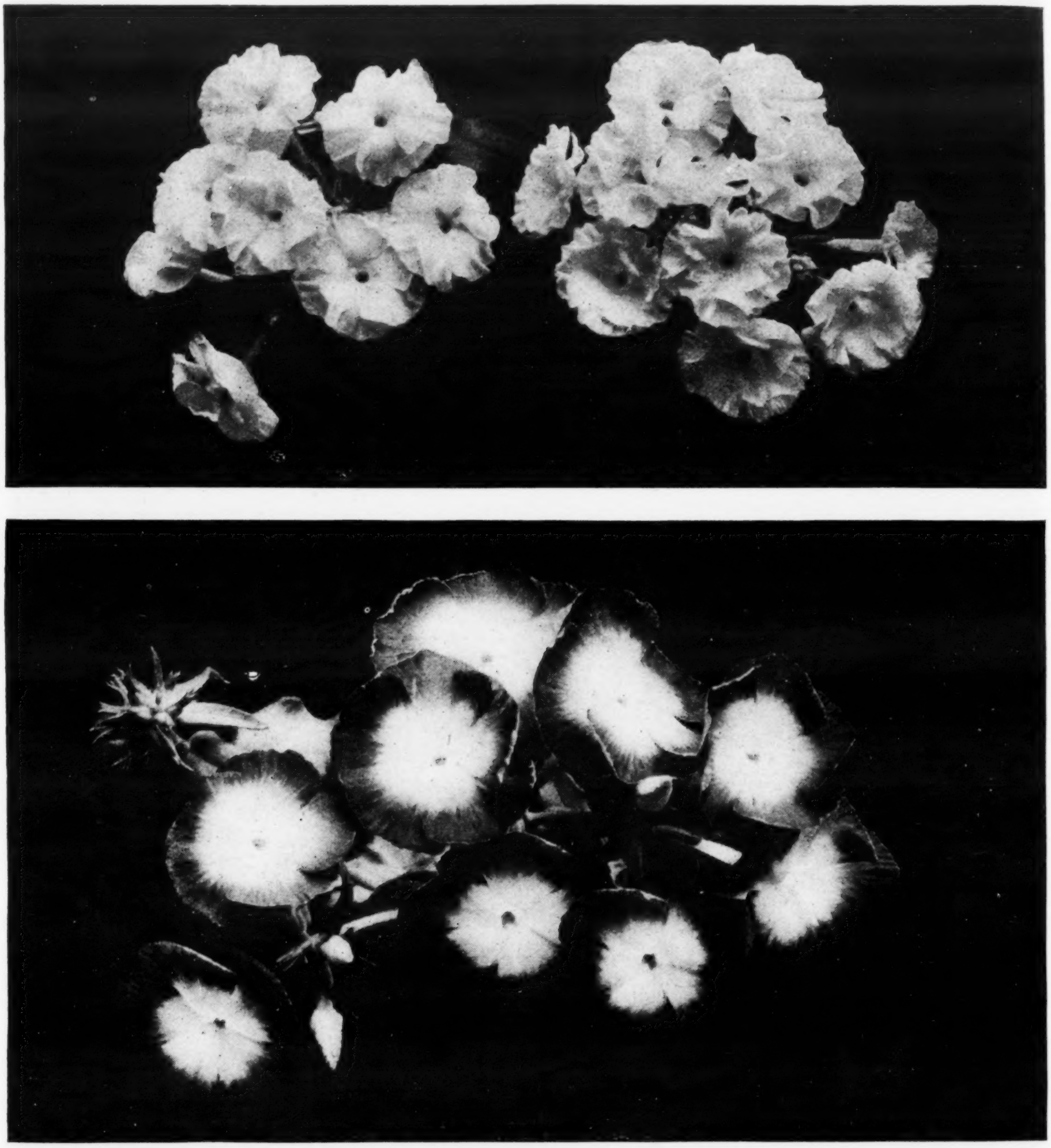


ASTYLIS AND ORBICULARIS PHLOX

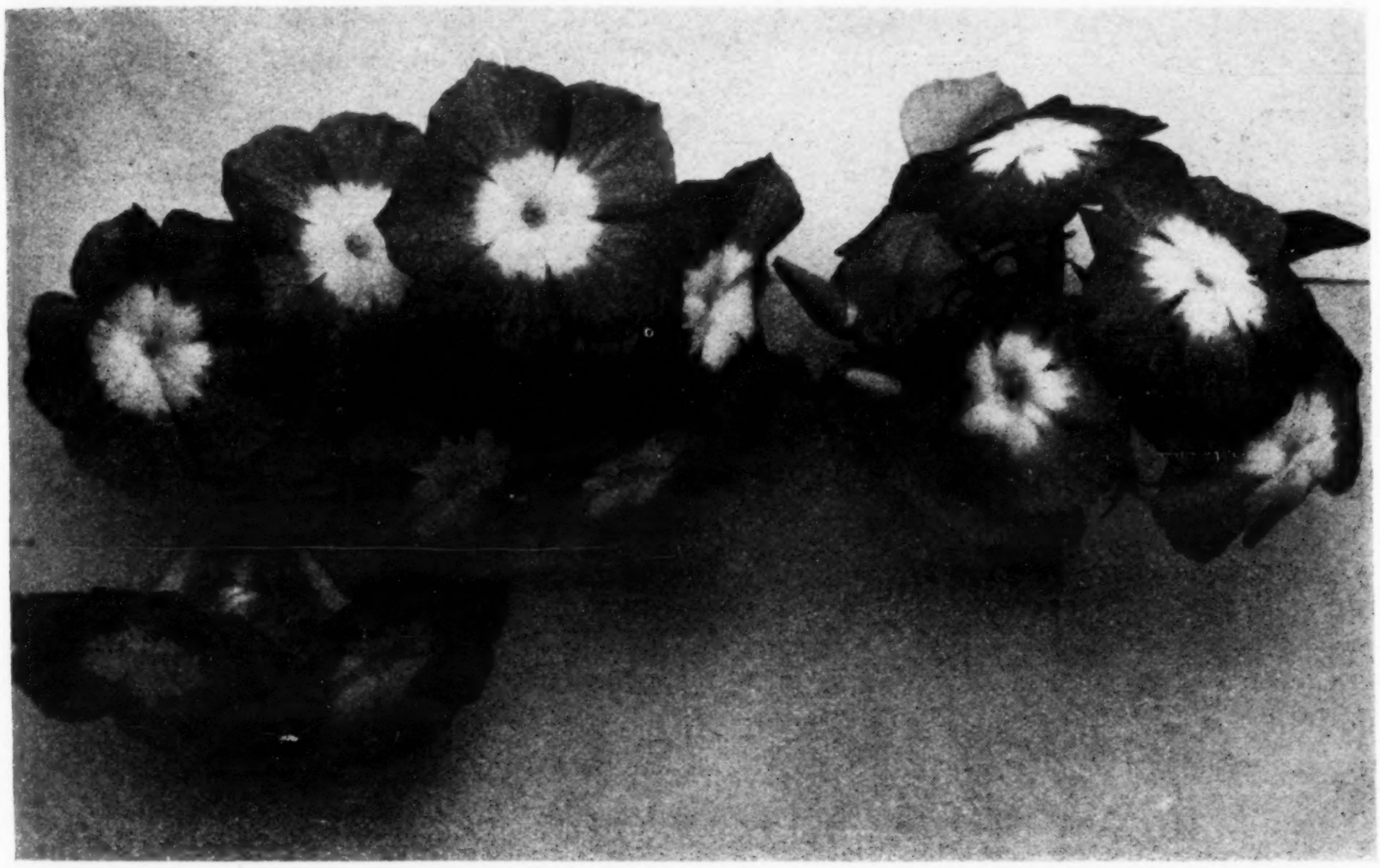
FRONTISPIECE. As an illustration of how genetics enables us to analyze the hereditary make-up of living things this study of inheritance in phlox is instructive. The small, white-flowered, *astylis* form was found in a supposedly pure strain of small-eyed phlox (Figure 1), and also appeared on inbreeding the large-eyed *orbicularis* variety. Crosses were then made between *astylis* and small-eye and the plants of this first hybrid generation were all of the *orbicularis* type. That is, small-eyed and *astylis* are genetically pure strains, which normally would be expected to breed true (if *astylis* were not self-sterile), while *orbicularis* is of hybrid origin, containing the genes *astylis* and small-eye in the heterozygous condition. The hereditary determiner of the small-eyed character is only partially dominant over *astylis,* and the *astylis* "blood" has the effect of inhibiting the development of anthocyan color except in the periphery of the petals.

ASTYLIS PHLOX

The Relation of This Variation of Phlox Drummondii to the Large-Eyed Flower[1]

JAMES P. KELLY

Penn. State College, State College, Penn.



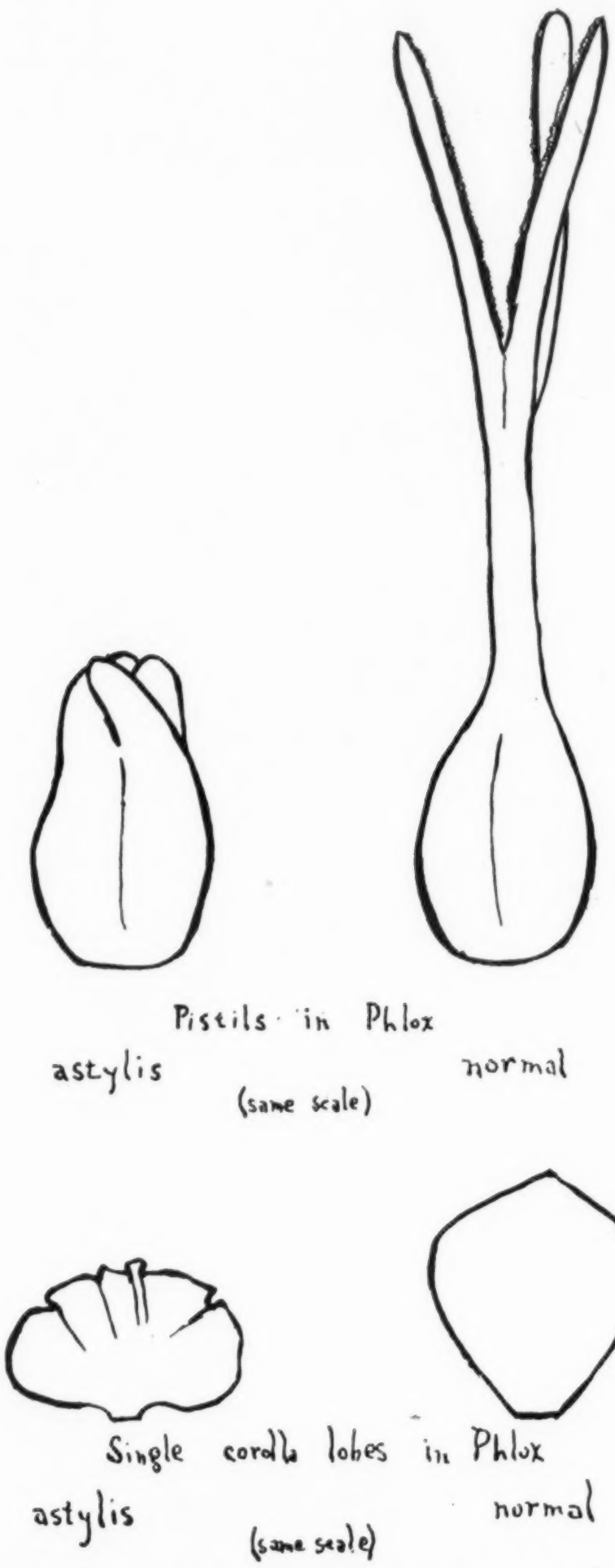
SMALL-EYED PHLOX

FIGURE 1. Pure strains of small-eyed phlox are easily produced by the breeder, but this is not possible with *orbicularis,* for a study of its genetic constitution proves it to be of hybrid origin. Three types of plants, having *orbicularis, astylis,* or small-eyed flowers, are produced by self-fertilized *orbicularis* seed, but the cross between *astylis* and small-eye produces only *obicularis* plants.

IN 1920 there appeared in some cultures of Drummond's phlox grown from German seed a striking and unexpected type of flower. It cropped out in two individuals of a variety supposed to have only normal pink flowers with a small white center, or eye. The new type of flower was exceptionally small, entirely white, and with ruffled or wavy corolla lobes of relatively great width. Closer examination revealed that while pollen was present in normal abundance the style was totally lacking, hence the name *astylis* bestowed on this variation. (See Frontispiece). Repeated hand pollinations were tried on the *astylis* individuals but not a single seed was formed, and experience of subsequent seasons with other *astylis* plants has confirmed the fact of sterility as far as the ovary is concerned. Fortunately, *astylis* pollen is viable and some crossings in which it was used proved successful.

At the time that the *astylis* plants were discovered the writer had under observation two plants of the *orbicularis* type of *Phlox drummondii.* (See

[1] Contribution No. 40 of the Botany Dept., Pennsylvania State College.



NORMAL AND ASTYLIS PISTILS AND COROLLA LOBES

FIGURE 2. *Astylis* plants are sterile because the ovary is undeveloped. Fortunately, the pollen is viable, and crosses with other kinds of phlox can be made. The self-sterility of *astylis* makes it impossible to raise pure *astylis seed*.

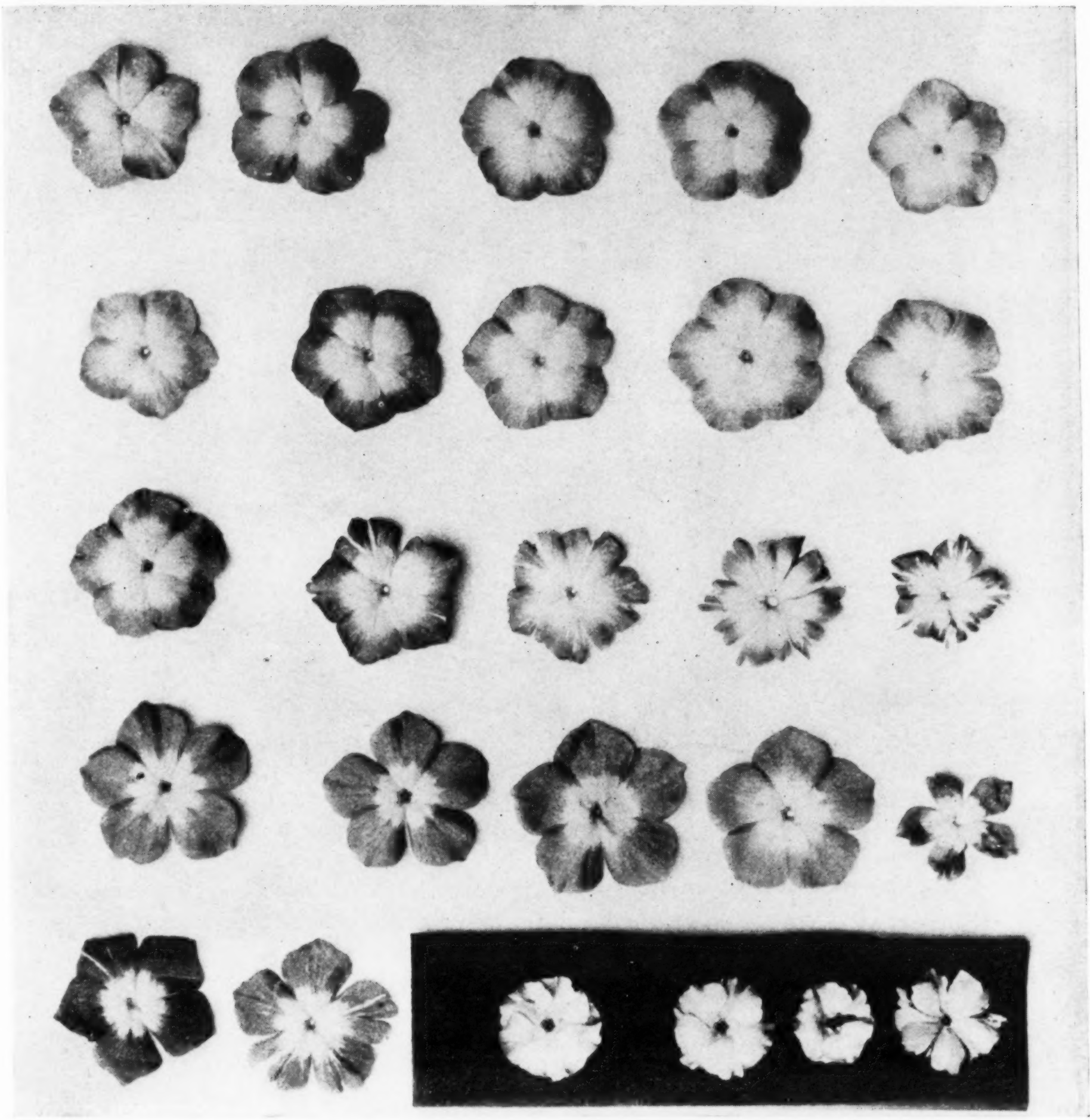
Frontispiece.) The flower in this form is normal, particularly as regards style development, and is distinguished by having the anthocyan pink color more nearly confined to the periphery of the corolla than in any other phlox. The center of the flower is occupied by a relatively large white eye. The genetic analysis of this large eye was undertaken and both self pollinated seed and crosses with other varieties were obtained.

The Origin of the Orbicularis Variety

It was not expected at the time that the paths of investigation of *astylis* and of *orbicularis* would converge and become one, but observation very soon revealed *among the progeny from self-pollinated orbicularis more of the peculiar astylis plants.* These new *astylis* individuals had as sibs large-eyed plants, just like the orbicularis parent, and also small-eyed ones, both kinds bearing normal styles as far as observed. *Orbicularis,* then, on inbreeding, besides having reproduced itself, produced *astylis* plants, and a small-eyed kind as well. Furthermore, it was found that when a plant whose flowers have a small white eye with a wide colored periphery was crossed with *astylis* the progeny all have flowers with large white eyes and narrow periphery; *i. e., the F₁ hybrid generation of small-eye and astylis is orbicularis.* Two such crosses have been made giving rise to a total of nineteen progeny—uniformly *orbicularis.*

Five crossings of *orbicularis* plants and small-eyed ones have been made. There resulted 32 offspring of which twenty had the large white eye and twelve the small white eye.

From the *orbicularis* plants, including both the original commercial ones and those experimentally produced, 14 families have been secured through self-pollination. The total of progeny was 351, of which 84 were *astylis,* and 156 *orbicularis,* while 106 had small-eyed flowers. Five non-*astylis* plants were left unclassified because the eye was intermediate in size. *Astylis* segregates being sterile, could not be further tested by selfing. Three of the small-eyed segregates arising in the experiments gave on selfing 56 progeny of which 55 were small-eyed and one (a stray seed?) had a large eye. Small-eyed phloxes not included in the present



PROGENY OF AN ORBICULARIS PLANT

FIGURE 3. Each of the twenty-six flowers is typical of the plant from which it came. Note practical absence of anthocyan color in the four *astylis* flowers. In this family the small-eyed and the *astylis* plants (if *astylis* were not self-sterile) would be expected to breed true, whereas the progeny of the *orbicularis* plants would split up again in the next generation much as has been the case above.

study have long been in pedigree cultures of the writer and have never been known to throw anything but small-eyed plants.

It seems, therefore, that the *astylis* condition is dependent on a single recessive gene for its manifestation. There is a group of associated characters apparently due to this single factor. When in homozygous condition there follows an inhibition or loss of the style, reduction of the stigmatic branches, increase in the relative diameter of the corolla lobes, ruffling of corolla lobes, and decrease in the size of the flower. The existence of the large-eyed condition is due to this *astylis* gene in heterozygous condition. It converts the small-eyed flower into the large-eyed kind by limiting the develop-

PLANTS OF THE THREE TYPES

FIGURE 4. The effect of the *astylis* gene seems to be to inhibit the development of anthocyan color in the central "eye" of the flower, when in the heterozygous condition, and to result in the development only of this "eye" region of the petals when it is in the "pure" or homozygous state. Note that the size of the *astylis* flower is approximately that of the "eye" region in the *orbicularis* form.

ment of the anthocyan color in the corolla to a narrower peripheral ring. curiously enough, the large white eye is not brought out when the *astylis* gene is homozygous. It seems then to cause the cutting off from development of the corolla periphery, the part that would show the blade color, leaving merely the large white eye; hence, too, the small size of the flower blade. A white *astylis* bloom may be looked upon as just the eye region of a flower with large white eye that has lost its periphery due to the absence of the gene. Figure 3 represents one entire family secured by inbreeding an *orbicularis* parent whose large white eye was surrounded by a Tyrian-pink border. All the non-*astylis* plants have borders of this color, but the *astylis* sibs of these colored plants are white or practically so. Occasionally a faint fleck or tinge of anthocyan may be detected on such plants.

Is it possible to interpret this situation on the basis of a close linkage of factors for white and *astylis?* Certain details of the experiments make this proposition unlikely. Some of the *orbicularis* plants of 1921 were heterozygotes of white and cream.[2] The cream had been introduced through a normal non-*astylis* parent. In 1922 six such heterozygous *orbicularis* plants gave 218 progeny as shown in the accompanying table.

These data indicate no linkage of white and *astylis*.

The large-eyed condition found in the variety *orbicularis*, therefore, is a heterozygous character and presents a genetic situation similar to that already reported by the author for the *fimbriate* phlox.[2] One could not expect to secure a true-breeding strain of *orbicularis* with the existant genetic constitution of *Phlox drummondii*, but this investigation shows that stands which are one hundred per cent *orbicularis* may be obtained by hybridizing *astylis* and the small-eyed variety.

TABLE 1. *Distribution of the Progeny of Six Orbicularis Plants.*

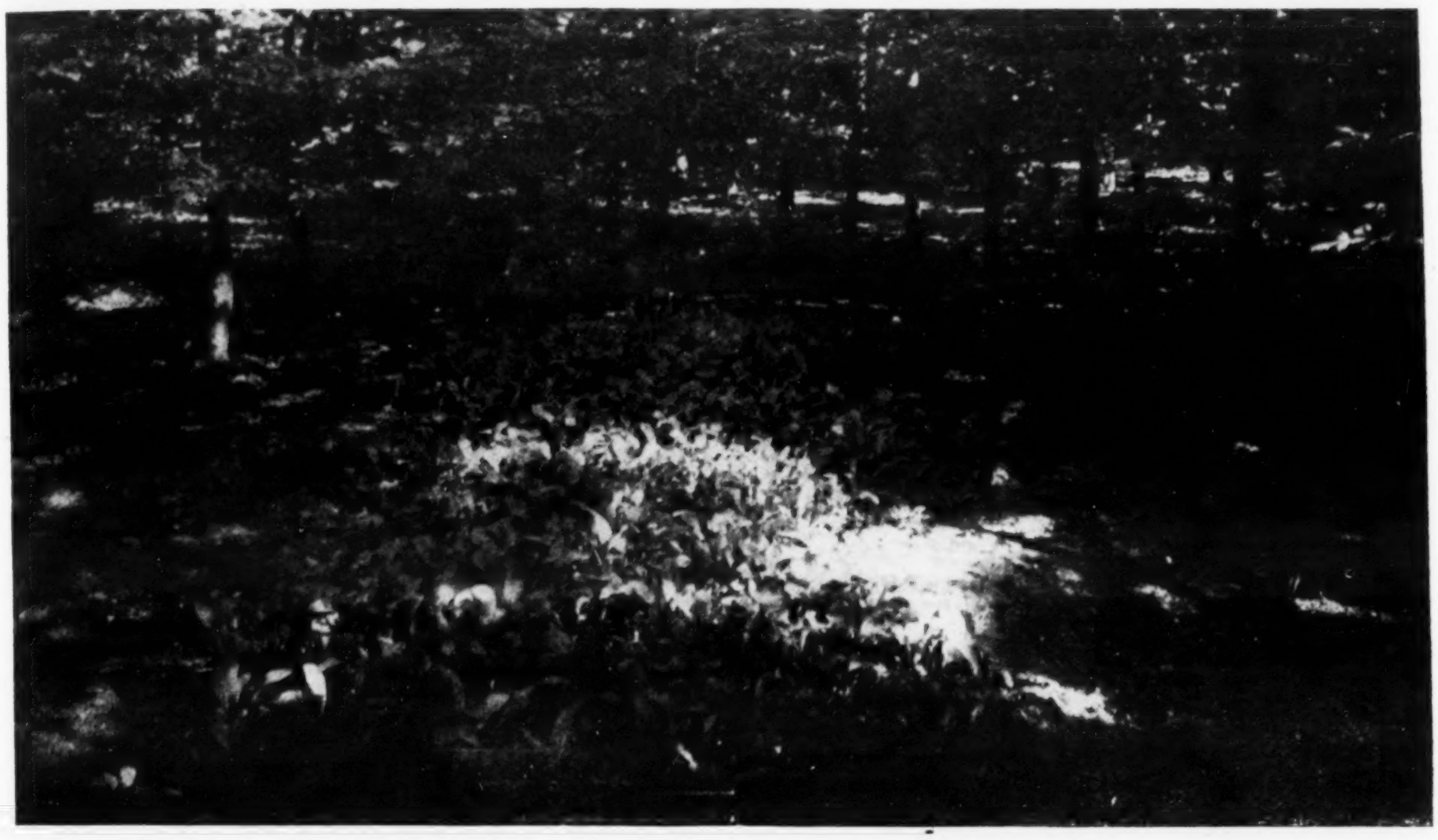
Astylis		*Orbicularis*		*Small-eyed*	
White	Cream	White	Cream	White	Cream
40	10	80	24	49	15

[2] The writer has already shown that cream is a simple recessive of white. See *Genetics*, *V*; 189-248.

AN HISTORIC SPOT FOR STUDENTS OF GENETICS

J. C. Theodore Uphof

Orlando, Florida.



THE PRIMROSES OF SPANDERSWOUD

Figure 5. About 1885 this was a neglected potato field, and here Hugo de Vries discovered the mutant form of the Evening Primrose, on which he based his theory of evolution by mutation. Since that time the forest of beech and spruce trees has grown up and nearly wiped out the Oenotheras. In 1921 only a few were left and the shade was so dense that photographs were impossible. The pictures shown here were made in 1908, and as far as known, are the only ones published of this interesting place.

NOT far from Amsterdam, a road branches off to the westward from the highway between Bussum and Hilversum. It leads through sandy fields and pine forests to the region of the lakes of Ankeveen. Passing through the old Dutch private estates of Swanenburg and Boekenstein, surrounded with beautiful gardens and woods, the traveller reaches Spanderswoud, one of the largest estates in that part of the country. It was here in 1886 that Hugo de Vries found the first mutating Oenotheras, which were so important in the upbuilding of his theory of mutation.

According to de Vries, the Oenotheras were found in a neglected potato field, where they grew abundantly. The writer visited this place repeatedly between 1904 and 1908 and found it largely covered with a mixed forest of beech (*Fagus sylvatica*) and spruce (*Picea excelsa*). The forest was about fifteen years old, but some patches of *Oenothera lamarkiana* were still to be found in the open places.

Among the several thousand plants of the mother species there were but few of the forms to which de Vries gave the name *O. nanella*. In the autumn, when only the leaf rosetts were

A MUTANT ON ITS NATIVE HEATH

FIGURE 6. Three rosettes of the normal *O. lamarkiana* are shown, and in the right foreground is one of the mutants, a tiny plant of the type called *O. nanella* by de Vries.

THE FOUNDATION OF A GREAT THEORY

FIGURE 7. Even should de Vries' theory of evolution be finally discarded by students of biology, there could be no doubt of the value of his researches. They gave the impetus so much needed to make the study of evolution an experimental rather than theoretical science. Great strides have been made in our understanding of heredity and evolution, until now we have reached the paradoxical position of realizing how little we really know about this most interesting of subjects,—the scientific study of life itself.

to be found, I observed sporadic individuals of the minus mutant, so different from the typical *lamarkiana* in leaf form. Figure 6 shows in nature rosettes of *Oenthera lamarkiana*, between which a mutation, *nanella*, is growing. This plant was removed to my garden near Amsterdam, where it flourished and produced seed. Its offspring were all dwarfs, which emphasized de Vries' observation that *nanella* is one of the most constant of the mutants.

Between 1910 and 1921 the beech and spruce trees increased considerably in size, whereas the Oenotheras decreased in number so greatly that it appears that they will become extinct in a few years. It was practically impossible to get photographs of the few remaining specimens, therefore the accompanying photographs are those of the plants found in 1908.

As far as I am aware, no photographs have ever been published of this historical and remarkable place, the starting point for investigations which have figured so conspicuously in modern discussions of the origin of new forms of living organisms. To students of genetics it may be especially interesting to have these pictures reproduced during the month of February, when Hugo de Vries, the founder of Experimental Evolution, reaches the seventy-fifth anniversary of his birth.

No doubt all geneticists agree that Dr. de Vries' theory and researches of evolution have thrown a powerful beam on the phenomena of the origin of species. His brilliant discoveries and his revival of Mendel's researches have stimulated scientific investigation and laid the foundation for much successful work in plant and animal breeding.

Hybrids and Mutations of Campanula

INTERESTING results are reported by Lathouwers for experiments with *Campanula medium*. Hybrids between rose colored and white flowered varieties gave in the first generation dark violet-colored flowers, and in the second generation five classes of flower color are reported, white, rose, dark violet, violet, and lilac in various proportions. These results were difficult to understand, but were finally adjusted to Mendelian theories by assuming four genetic factors. A basic color factor, and a "revealer" must both be present to produce color. A third factor is supposed to determine alkalinity, and to be responsible for violet or dark violet instead of rose or lilac. The fourth factor is assumed to be an intensifier, changing violet into dark violet or rose into lilac.

When the third factor is absent a form called *monantha* appeared, considered to be a true mutation. It is characterized by a large solitary flower, with no lateral flowers or branches. Suddenly in a pedigree culture after two generations of self-fertilization the mutation was represented by eighteen individuals, while seventy-five other plants retained the normal form. This same mutant form appeared in later generations, and came nearly true to seed. Crosses were also made with this and other floral abnormalities.[1]

[1] See LATHOUWERS, M. V. Researches Experimentales sur L'Heredité chez *Campanula medium L.* L'Academie Royale de Belgique. No. 1283. 1922.

GLANDS AND PERSONALITY

A REVIEW

THE GLANDS REGULATING PERSONALITY, *by* LOUIS BERMAN, Associate Professor of Biological Chemistry at Columbia University. 300 pp. Price, $2.50. The Macmillan Company. New York, 1922.

Dr. Berman seeks in this book to point the way to the regulation of personality. He is deeply imbued with the idea that traits of character, disposition, our transient moods, are the expression of the process of secretion of these glands. "What in our cells is pugnacity? What in our bones is greed? What in our blood is sex? What in our nerves is fear? Until these inquiries are respected, conscious character building or even stock breeding must remain the laughing stock of the smoking rooms and the regimental barracks." Speaking of the glands of internal secretion, "In short, they control human nature and whoever controls them controls human nature."

The author gives a most interesting historical account of the studies upon the endocrine glands, and then takes up each in turn and gives pithy, epigrammatic characterizations of them. "It is . . . permissible to think of the thyroid as a dictator of evolution, to crown it as the vertebrate gland *par excellence* and to call the typical vertebrate brand-marks secondary thyroid characteristics in precisely the sense of Darwin classing the horns of cattle as secondary sexual characteristics."

Functions of the Glands

In dealing with the pituitary gland, he distinguishes only two portions—the anterior and posterior. Really the matter is more complex, since the part that he designates the anterior lobe is made up of three different elements, at least two of which have entirely distinct functions. In a summary statement, he says, "while the thyroid increases energy evolution, and so makes available a greater supply of crude energy by speeding up cellular processes, the pituitary assists in energy transformation, in energy expenditure and conversion, especially of the brain and of the sexual system. In short, the thyroid facilitates energy production, the pituitary its consumption."

In discussing the well known distinction between the cortical and medullary portions of the adrenal gland, he makes the statement that the cortical portion is relatively larger in man than in any other animal. Upon this claim and from asserted cases of abnormal development, he draws the rather bold conclusion that "the human brain therefore owes its superiority over the animal brain to the adrenal cortex, in development anyhow. The growth of the brain cells, their number and complexity is thus controlled by the adrenal cortex."

Of the thymus gland he says, "The thymus is the gland which dominates childhood. It appears to do so by inhibiting the activity of the testes and ovaries. Castration causes a persistent growth and retarded atrophy of the thymus. Removal of the thymus hastens the development of the gonads." He lays much stress upon the experiments of Gudernatsch in which he claimed that he had retarded development toward maturity in tadpoles by feeding them thymus material. This experiment, however, has not stood the test of repetition in later experiments by Swingle, Uhlenhuth and others. We must frankly admit that we have as yet no reliable knowledge of the function of the thymus gland—today we are more in the dark about it than ever. This is an example from many that might be chosen to illustrate the

tendency Berman shows to make far-reaching generalizations upon an insecure foundation of scanty, conflicting evidence.

Berman, in his treatment of the pineal gland, is even less justified from the evidence in hand, saying, "The pineal, the ghost of a once important third eye at the back of our heads, still harks back in its function to a regulation of our susceptibility to light and its effect upon sex and brain. So it becomes one of the significant regulators of development, with an indirect hastening or retardation of puberty and maturity according as it works in excess or too indolently." This seems to be a very rash statement indeed in the light of our present scanty knowledge of the function of this gland.

Types of Personality

Berman assigns the majority of human personalities to one of three principal types.

A. Thyroid centered type—Bright eyes, good, clean teeth, symmetrical features, moist, flushed skin, temperamental attitude toward life, tendency to heart, intestinal, and nervous diseases.

B. Pituitary centered type—Abnormally large or small size, musical, acute sense of rhythm, asymmetrical features, tendency to cyclic or periodic diseases.

C. Adrenal centered type—Hairy, dark, masculinity marked, tendency to diphtheria and hernia.

"These are some of the master types. They have their variants depending upon the influences of the other glands, especially the interstitial glands".

"We know also that the thyroid dominant tends to be irritable and excitable, the pituitary deficient to be placid and gentle, the adrenal dominant to be assertive and pugnacious, the thymus-centered to be childish and easy-go-lucky and the gonad deficient to be secretive and shy. This brings us to the relation of the internal secretions to the type of personality as a whole". This is a typical passage showing how he attempts to explain very complicated conditions in a word. Such sweeping statements seem quite unwarranted in the light of our present knowledge, although we can appreciate the grain of truth in each assertion.

The chapter on the sex-glands is presented in striking fashion and contains a large amount of information in small compass.

It is hard to believe with our author when he says, regarding the adrenal gland, "all evidence points to its medulla as the secretor of the substance which makes for the phenomena of fear, and to its cortex as dominant in the reactions of anger." This seems to be carrying things a bit too far.

Examples from History

It is in the characterizations of personages of history that Berman makes some of his most striking statements and departs most widely from serious science to wander in the realms of phantasy. Napoleon was "a pituitary centered, ante-pituitary superior, post-pituitary inferior, with an instability of both that would lead to his final degeneration. Besides his insatiable energy indicated an excellent thyroid, his pugnacity, animality and genius for practical affairs a superb adrenal."

Nietsche's character is explained as "pituitary centered, with post-pituitary domination, a superior thyroid and inferior adrenals". Darwin "had poor adrenals, superior pituitary ('the nidus of genuis') and an overacting thyroid." Caesar showed "a most delicate balance between his ante-pituitary, post-pituitary, adrenals and thyroid". "That his thyroid functioned well can be deduced from a career which involved more than three hundred personal triumphs." "The masculine love of glory and ambition, expression of a well working ante-pituitary, was combined with the effeminate echoes of an equally well evolved post-pituitary." "He was a rather muddled careerist because he

had too much adrenal and post-pituitary." Dr. Berman deals with Florence Nightingale and Oscar Wilde in equally assured fashion.

Under the heading *pucriculture*, he says, "periodic, seasonal and critical fluctuations in the equilibrium among the hormones will have to be taken into account in the explanation of what have hitherto been put down to laziness, naughtiness, stupidity, or obstinacy."

Biologists will hardly agree with Berman that "The feeding of thyroid to a gifted father before procreation might enhance immeasurably the transmission of his gift as well as of its intensification in his offspring."

Of the book as a whole, it contains a large amount of information and is written in a most fascinating style that will make a strong appeal to the non-scientific public. Dr. Berman has made a most readable book, but in achieving this end he has thrown scientific sobriety and caution to the winds. The book is largely a romance that reminds one of such books as Moore's *Utopia*. It is true that in a book written for the general public one can not expect a full discussion of the various discordant opinions, but one has a right to expect that the author shall hold himself to the statement of facts reasonably well attested by scientific investigation. Dr. Berman too often accepts the wildest speculation and presents it as solid fact. He makes a facile analysis of the personalities of historic characters upon the basis of their endocrine makeup. No one can deny that the glands of internal secretion do profoundly influence personality—this having been especially well demonstrated in the case of the germ glands. While all this is true, at the same time, a hundred years of painstaking experiment will be required to give us a fairly satisfactory insight into the truth or falsity of the statements that Dr. Berman makes without the slightest qualification.

While this book will undoubtedly arouse a large amount of popular interest in the glands of internal secretion, it is greatly to be feared that it will mislead the public upon many vital points. It is quite certain that people are induced by it to expect entirely too much from the medical profession along the lines indicated. While such books as this will arouse a sensation it is much to be feared that the disillusionment that is bound to follow will react unfavorably to science and to medical practice.

Bennett M. Allen,
University of California.

The Facts of Social Hygiene

Plain Facts, *by* J. H. Kellog, M. D., Chief Medical Director of the Battle Creek Sanitarium. 2 vols., pp. 932, with numerous illustrations. Battle Creek, Mich., Modern Medicine Publishing Co., 1921.

In these comprehensive volumes (first published in 1917) Dr. Kellogg not only deals with almost the whole of the great field of social hygiene, but introduces a large amount of valuable instruction in physiology and hygiene at the same time. On sexual questions the author's point of view may be described as old-fashioned—which will be an unfavorable criticism in the minds of some, a commendation in the minds of others. A sound eugenic outlook is maintained throughout. Insistence is laid on the importance of heredity but the charts (based on eye color in man) to illustrate Mendel's Laws, will be misleading to those who have no previous knowledge of the subject.—*P.P.*

DUCTLESS GLANDS AND DEVELOPMENT

Amphibian Metamorphosis Considered As Consecutive Dimorphism, Controlled by the Glands of Internal Secretion

JULIAN HUXLEY

Oxford University, England

A GREAT deal of work has been done on the problem of Amphibian Metamorphosis since the discovery of Gudernatsch[10]* that a thyroid diet caused precocious metamorphosis. It is not my purpose here to summarize this work, but to try to set out the problem in the most general light possible, and to draw attention to parallels with other lines of work which seem to promise fruitful results. Especially I would like to draw attention to Amphibian Metamorphosis as offering unequalled opportunities for studying developmental physiology from a rather new angle.

It is clear today that the thyroid plays a predominant role at metamorphosis with the pituitary as junior partner; but further than this it has been difficult to penetrate. There are two main problems which have attracted attention. The first may be summed up in a question: Why does the thyroid act at metamorphosis and not before? Young tadpoles of Anura long before metamorphosis have a well-developed thyroid, as does the facultatively neotenous Siren.[11] Why is it that the thyroid in these cases does not produce its characteristic effects? And how is it that in some species of Anura metamorphosis occurs within a few months, in others, as in bull-frogs, only after two or three years?

The second problem is equally general. Granted that the thyroid does produce metamorphic effects, how does it do so? Why does thyroid feeding not produce metamorphosis in permanently neotenous species such as Necturus?[14, 21] Why do certain tissues, such as the gills and fins, react to thyroid treatment by regression and resorption, while others, such as the legs of Anura, by active growth? Why, further, do similar tissues, such as the limbs, behave differently in Anura and in Urodela? If a certain amount of thyroid be necessary for growth in human beings, as is shown by the bad effects of congenital lack of thyroid in cretins, how is it that thyroidectomised tadpoles show a perfectly normal or indeed accelerated growth rate?

In regard to the second point, most authors, if they discuss it at all, agree that the changes in the larval organs at metamorphosis are of a similar kind to those seen in dedifferentiation of whole animals (e. g. Clavellina) or in involution of organs. Something occurs which affects these particular issues so that they can no longer remain functional.

The first point has hardly received the attention it deserves. The only hypothesis, so far as I am aware, which attempts to deal with the matter, is that which in various forms is advanced by Uhlenhuth,[22] Swingle[21] and others. It is that during the larval period the function of the thyroid is purely one of storage, but that just before the time of metamorphosis, a change occurs in it, and it starts to excrete its stored products, which only then can affect the body and so bring

*For numbered references see "Literature Cited" at end of article.

about metamorphosis. Uhlenhuth believes that a definite "excretor substance" is produced in some organ of the body as the result of general somatic differentiation, and that this affects the thyroid and causes it to liberate its secretion.

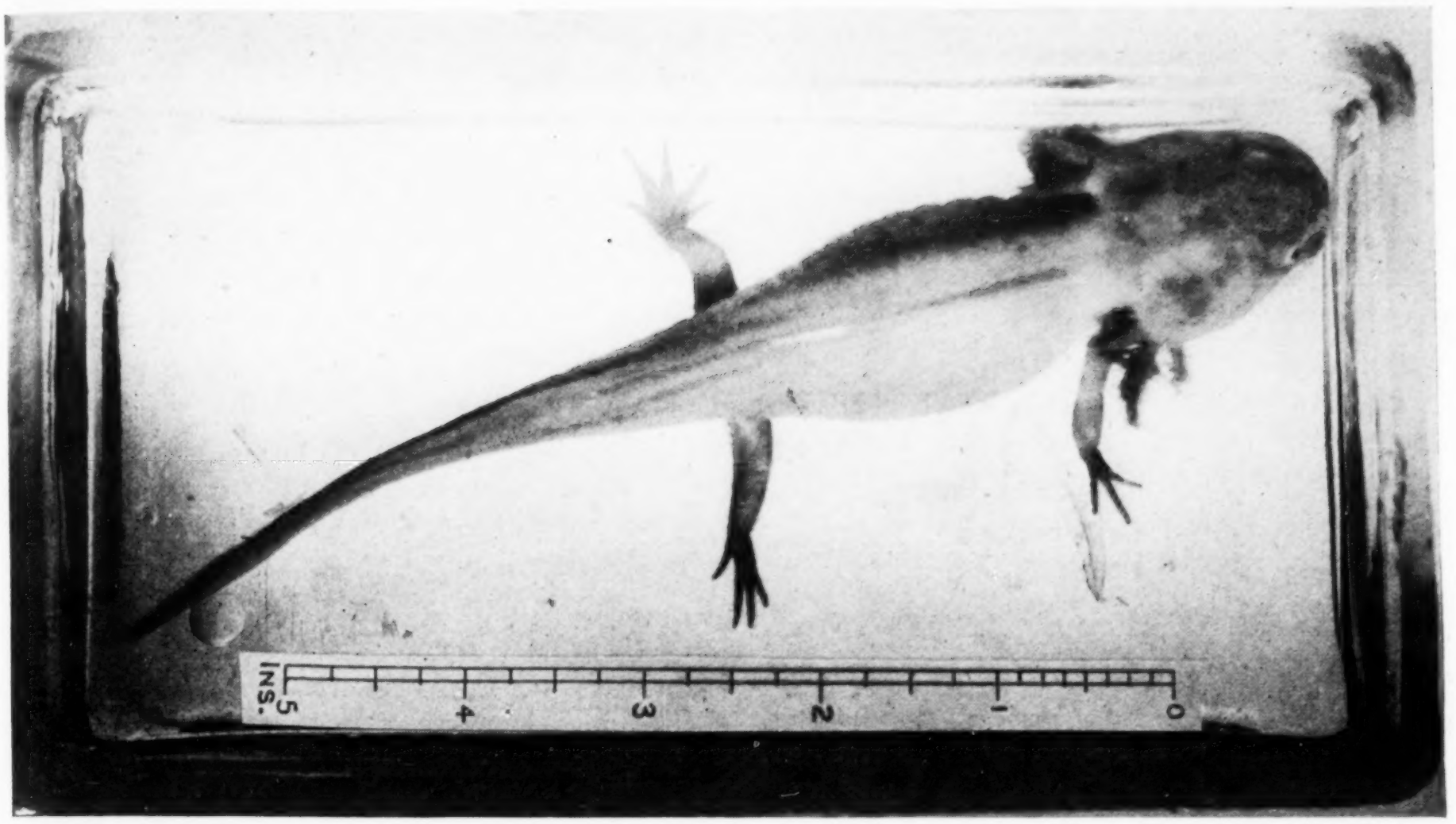
This, I must confess, appears to me to give no more than a formal explanation of the phenomena, and, furthermore, to be unnecessarily complicating matters. I may be pardoned if I digress for a few moments to another field for illustrations which I believe will throw light on the problem.

As is well known, Goldschmidt[8] has made a careful study of the sexually abnormal individuals produced by certain crosses between the European and Japanese races of Lymantria, the Gipsy Moth. He showed by a careful analysis that they could only be explained as individuals which have begun their lives as members of one sex, but had, at some time in their development, come to a critical point after which they continued to develop as members of the other sex. The commonest types of abnormal individuals are those which start as females, but finish as males. Since the chitinous hard parts of an insect are permanent, those which are laid down during the "female" part of the development persist even after "male" development has begun. Soft parts, however, such as the gonads, undergo a reconstructive process. If the critical point occurs early, before the formation of any chitin, complete sex-reversal takes place, and all individuals produced are of one sex.

Analysis shows clearly that this type of sexual abnormality, whether it leads to complete sex-reversal, or to the intermediate condition of intersexuality, is due to the association of genetic sex factors of different "strength" or "potency." It is further clear that in moths, the male-determining factor is lodged in the sex-chromosome, so that the males possess two such factors, the females, one. The location of the female-determining factor is less certain. It appears to be inherited purely maternally. Goldschmidt believes it to be contained in the Y-chromosome, which in moths, where females are heterogametic, is confined to females; and to act on the cytoplasm of the egg before fertilization. Be that as it may, it appears to be definitely proved that it is inherited in the female line only, and that the amount of this factor present is the same in males and females.

In males there is thus a double dose of male-determining factor—call it *M*—to a single dose of female-determining factor, *F;* further, 2 *M* is more effective than *F*. Translated into ordinary terms, this would imply that the factors *M* and *F* are normally responsible for the continuous production of two substances, say *U* and *O*, which are responsible for the development of maleness and femaleness respectively, and that the total of *U* produced by 2 *M* is so much in excess of the amount of *O* produced by *F* that normal males are the result. Conversely in normal females, there is a single dose both of *M* and *F;* and further *F* is greater in its effect than *M;* and so *O* is produced in excess, and can exert its effects and give rise to females.

The commonest type of intersex, that which starts as female and ends as male, is an individual in which a slow-working *F* is combined with a fast-working *M* factor. This implies that the curve of *O*-production is depressed, that of *U*-production raised; this in its turn will mean *an intersection of these curves* during or before the formative period when differentiation is occurring, so that an original excess of *O* is succeeded by a later excess of *U* and the animal changes from female to male. The converse change from original male to the later female development scarcely ever occurs unless *two* slow-working *M's* are associated with a fast-working *F*, and



LARVAL FORM OF WHITE AXOLOTL

FIGURE 8. The axolotl is found in Mexico, where it has been used as an article of food for centuries. The "white" axolotls are a pale flesh color, with beautiful red gills. Normally axolotls do not metamorphose, but retain their larval form throughout life. Iodine or thyroid treatment produces metamorphosis, and this brings up the interesting question of why this change does not normally occur, as the axolotls have functional thyroids which produce metamorphosis when grafted into anuran larvae.

this will only happen in the second generation from a cross.

There would seem to be no reasonable doubt, after Goldsmith's work, that some such quantitative change in the "potency" of male and female-determining factors does occur, and that this change in potency implies a quantitative change in the amount of some substance produced during the course of development, which in its turn affects the development of sexual characters.

As to the precise way in which these sex-determining substances act, however, we are very much in the dark. In any event, we shall not be far wrong if we try to think in terms of metabolism. There is, at least, no doubt that the males and females of insects, (as well as of other organisms), possess different types of metabolism. The evidence for this is reviewed in Goldschmidt's book.[9] We may conceive of this in two main ways. Either the sex-determining substances are markedly specific in their action on sexual characters, i. e., act locally on particular organs, as does the hormone *secretin* upon the pancreas; this would appear to be the case with the sex-hormones of mammals and birds.[17, 18] The sexual differences in metabolism would then be secondary results of the different development of the gonads. Or else these substances act primarily upon metabolism, turning on one of two alternative switches, so to speak, which lead to two different types of metabolism, which result in different internal environments. In one environment one chain of relations would occur and would lead to male development. The primary effect of the sex-factor might concern some general fundamental function, such as oxidation, and not be specific or local in its action on sexual characters at all; in this case the primary effect would be on general metabolism, which would lead, as a secondary result, to sex-divergence. There remains a third

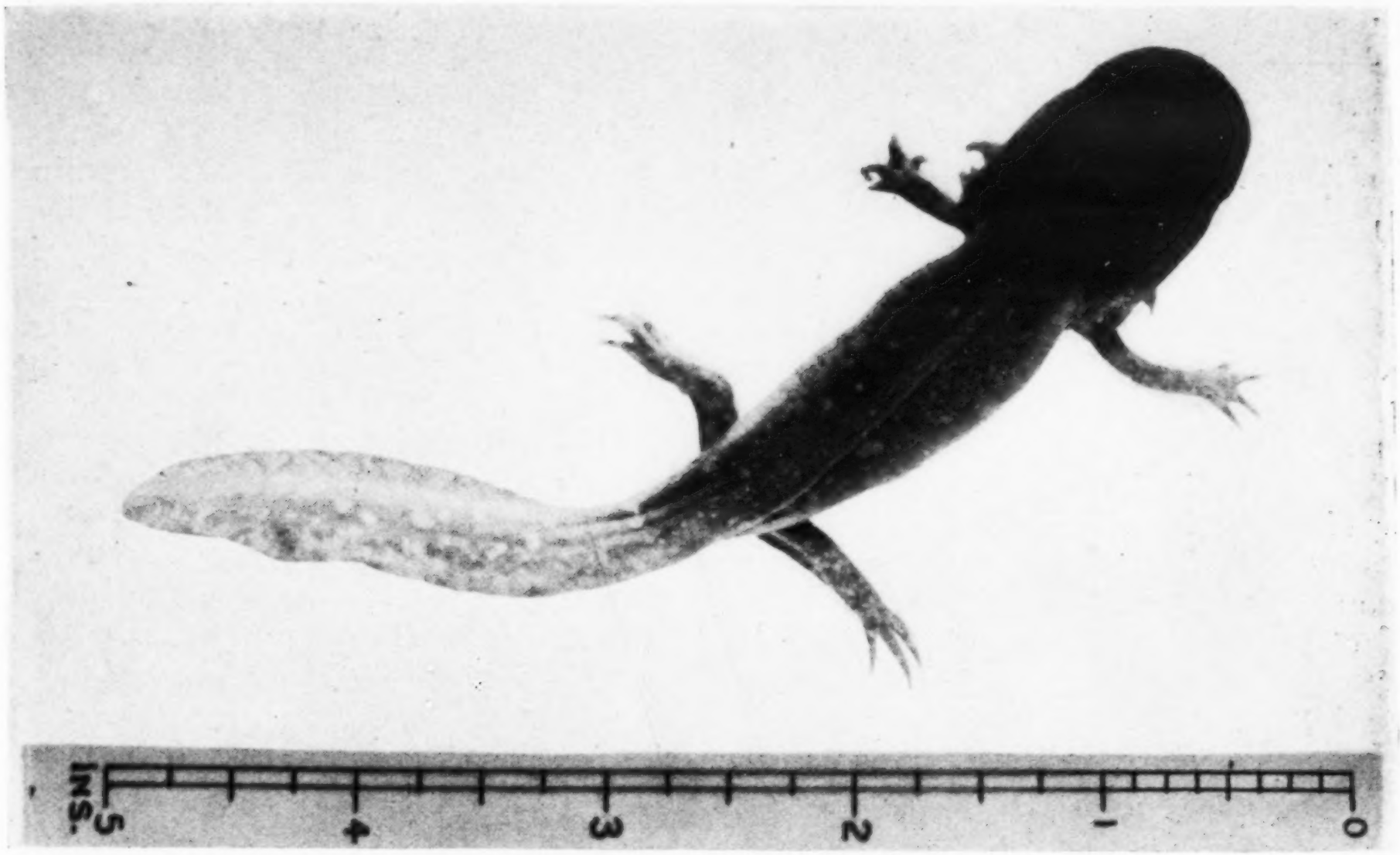
possibility—that the two apparent alternatives are as a matter of fact combined—that from the outset the excess of one of the sex-determining substances causes a change in metabolism, but that it also produces a specific substance promoting localized growth in one or the other set of sexual characters.

In higher animals, with gonads producing an endocrine secretion, the probability is that the first alternative is true, or quite possibly the third. For animals without a gondial hormone, however, as insects have been shown to be, the probability is that the second alternative, or again possibly some form of the third, is true.

We should remember that in various low forms, e. g., the oyster,[19] seasonal and age differences are associated with change of sex, that in other organisms, e. g., Hydra and certain plants, sex appears to be wholly or partially determined by external conditions. We can compare regulation of sex by environment, whether internal or external, to the regulation of dimorphism by environment, which occurs in certain plants. In *Polygonum amphibum,* for instance, and in *Ranunculus aquatilis,* it is well known that the plant may occur in two main forms, the aquatic and the terrestial. The assumption of one or the other of these forms is, however, not determined genetically, but by the environment of the plant. Its genetic constitution is so constructed that when the plant grows in water it will embark on a series of reactions leading to the water form, and *vice versa,* when it is on land. Here the influence on general metabolism is primary, the specific form-difference is determined secondarily as a result of the primary influence.

Finally in the Diptera, the group of insects to which the flies belong, we have fairly definite proof that the germinal factors responsible for sex-determination, or at least some of them, are of a nature which can hardly be supposed to exert specific effects upon the development of sex-characters, but can readily be supposed to act on general metabolism. In a very remarkable recent paper Bridges summarizes his work upon triploid stocks of Drosophila.[5] It is impossible to go into the evidence he presents, but a few points important to our general argument must be mentioned. In the first place, he shows conclusively that sex-determination in Drosophila is not, as was at one time held, a question of the *absolute amount* of some factor contained in the X-chromosome, so that two doses of X invariably produce females, one dose invariably males. Rather it is a matter of a relation between the amount of some factor carried in the X-chromosome and of some other factor or factors carried in the rest of the chromosomes.

His triploid stock usually carries three instead of the normal two sets of autosomes, together with either one, two, or three X-chromosomes. Let us call a single set of autosomes *A*. Then it was found that a chromosome formula 3X:3A gave normal femaleness, just as does 2X:2A in normal diploid stock. 1X:2A in diploid stocks gives normal maleness. 1X:3A in triploid stocks gives sterile "super-males"; while 2X:3A—an intermediate ratio—gives intersexual individuals combining male and female characters; 3X:2A individuals, discovered in other experiments, were sterile "super-females." Thus we have a state of affairs perfectly consonant with Goldschmidt's ideas. However, Bridges was able to push the matter still further in one direction. Owing to the fact that the small fourth chromosome, though sometimes present in triplicate like the rest of the autosomes, was at other times only present in duplicate, he was able to show that there was not a *single* male-determining factor, but at least two (probably many)—one (or one set) lodged in the fourth chromosome, the rest in the other autosomes. The set in the fourth chromosome appears to exert a disproportionately strong effect. Ob-



PARTLY METAMORPHOSED

FIGURE 9. Iodine treatment is having its effect most markedly in the reduced size of the gills. The dorsal fin is also smaller, but there is little change in the size or shape of the head. Metamorphosis appears to be caused by a change in the internal environment, resulting in a higher rate of metabolism. This is favorable to specifically adult tissues, but larval organs and tissues cannot "keep the pace" and break down. The specimen shown here is a black axolotl, while the one shown in Figure 8 is white.

viously the simplest way to envisage the problem here presented to us is to suppose, first, that a complete set of chromosomes is necessary for development; second, that a definite quantitative preponderance of certain factors contained in the autosomes results in a type of metabolism leading to an internal environment in which male characters are expressed; and third, that a preponderance of certain factors contained in the X-chromosome produces another type of internal environment in which female characters can develop.

It further follows that, in such a case, it is not necessary to postulate the existence of specific sex-determining factors at all, but merely of factors which influence metabolism in a way favorable to the expression of male or female characters, respectively. The difference between this and the state of affairs in plants like *Polygonum amphibium* is that in our cases the genetically-determined sex-chromosome mechanism normally provides the two proper quantitative relations of the two sets of factors, whereas in Polygonum there is no genetic basis for the regulation of the dimorphism. Haldane[11] has recently expressed the view not only that the assumption of specific sex-factors is unnecessary, but that it should not be made until the more economical alternative has been tested. Such an idea is borne out by the recent remarkable work of Blakeslee and his co-workers, on the effect produced by the presence of abnormal numbers of certain chromosomes in Datura.[4]

In any event, what is important for our present purpose is definitely established: (1) that the dimorphism of sex is brought about in higher animals by a zygotic difference in the *relative amount* of certain factors in

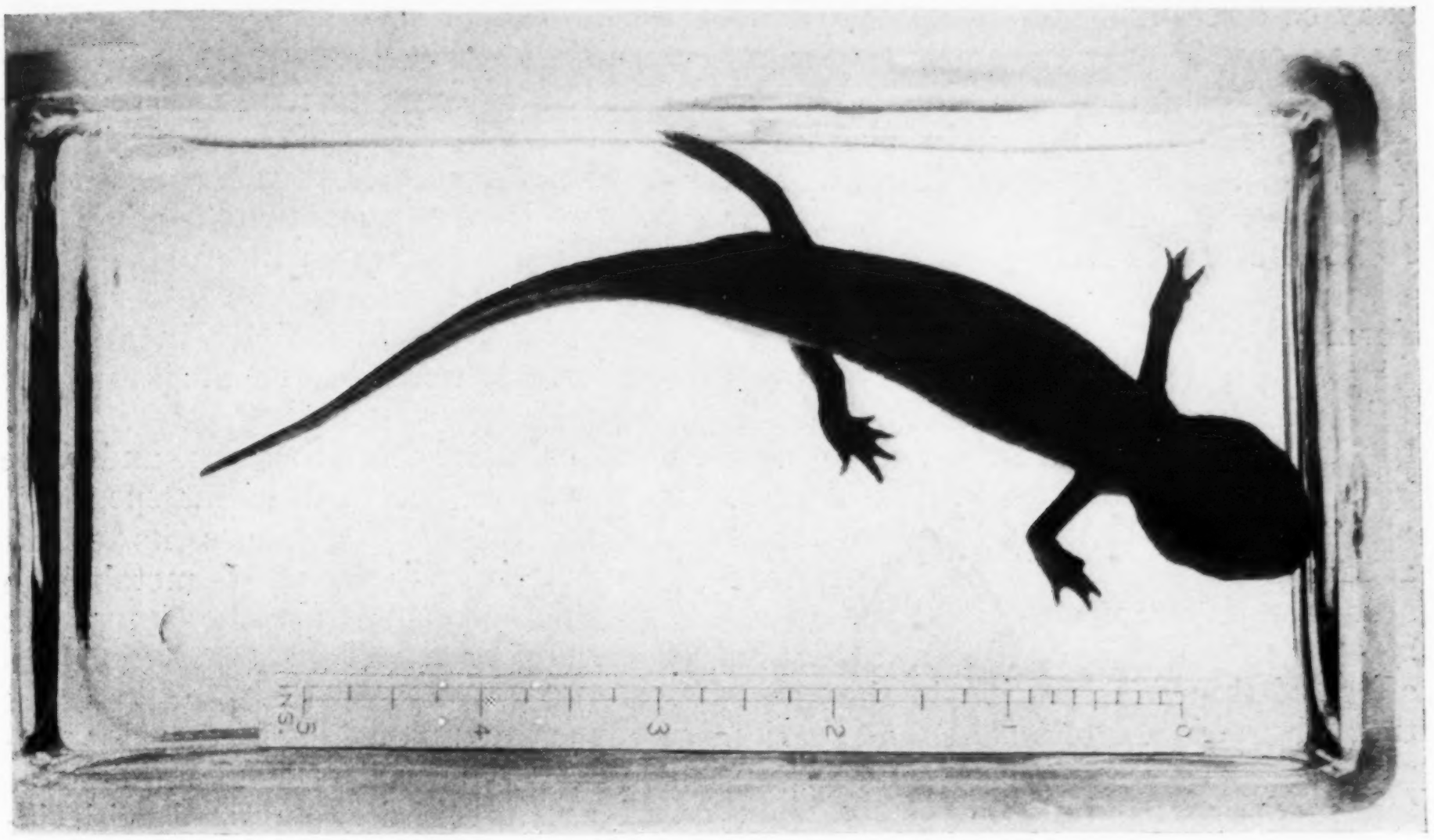
the germ-plasm, in other words is determined as the result of a certain *quantitative balance* between these genes; (2) that the *rate of working* of these factors is important, since their effect is ultimately exerted through their chemical activity; (3) that by making, through racial or species crosses, certain combinations of these factors, it is possible to produce a *consecutive intersexuality—i. e.*, sex-dimorphism in time in one and the same individual, one sex phase giving place to the other after a certain moment. This effect is due to combining relatively slow-working factors for one sex with relatively quick-working factors for the other, and to the consequent intersection of the curve of production of their sex-determining substance or substances.

Having established these points, we may profitably consider the last a little further. In the first place it should be noted that various animals besides the Gipsy Moth may show a similar sex-reversal during development; but in animals in which no hard parts connected with sex are laid down in permanent and unalterable form, the transformation from one sex to the other will almost always be eventually complete, since the soft parts of one sex will be absorbed or remodeled and those of the other sex laid down in their place. This, as a matter of fact, occurs in Frogs, as Witschi,[24] Crew[6] and others have shown. To get evidence of the sex-change here we must either argue indirectly from sex-ratio, or follow the individual during its development.

In the second place, there are a great many forms of life in which a consecutive sex-dimorphism—in other words, sex-reversal at a certain point of time during development normally does occur. There are the numerous bisexual forms that rise by male or female individuals taking on the characters of the other sex, and giving rise to protandric and protogynous hermaphrodites, the former kind being the more abundant. This question has been treated at length by Goldschmidt in the work previously cited[9]. Suffice it to say that frequently the change of sex appears definitely to be associated with and determined by a change in metabolism, such as that inevitably brought about by increase of size and age. Here one might speak of normal and abnormal sex-metamorphosis, normal in hermaphrodites, abnormal in Goldschmidt's moths and Crew's frogs.

This brings us back to the question with which we started—a question which this, I fear somewhat lengthy digression, has been intended to illuminate. In these cases which have been properly analysed, sex-metamorphosis has been shown to depend on the intersection of the curves of production of certain substances. The production of these, in their turn, depends upon the relative amounts or rates of working of certain factors in the organism's constitution. Why, we may then ask, if it is possible to have such sex-metamorphosis, should not a similar state of affairs be supposed to exist in true metamorphosis? I will endeavor to show that such a state of affairs may very probably be supposed to exist.

We have first to suppose—what is clearly the case—that the germinal constitution of the Anura (which I choose because the problem has in them been most intensively studied) is such that it interacts with the normal environment to produce the tadpole type of organization, and *this whether a thyroid be present or not.* The experiments of Allen[2] and others with thyroidectomized tadpoles show conclusively not only that normal healthy growth is possible in tadpoles without a thyroid, but that the tadpole organization will persist and grow to a size far above normal when no thyroid is present. Some of Allen's thyroidless tadpoles grew to a length of several inches and became almost as large as the normal metamorphosed adults of the species. It is quite clear, then, that the tadpole type of organization



METAMORPHOSIS COMPLETE

FIGURE 10. The dorsal fin and external gills have disappeared, the shape of the head has changed and the eyes protrude. There is also a marked loss of flesh. The thyroid is not specifically a metamorphosis-producing agent, and its effects are probably confined to speeding up metabolism. The time of metamorphosis in different species is determined by the ability of the larval tissues to hold together under the intensified metabolic processes set up by greater concentration of thyroid.

can exist independently of age or size *when no thyroid is present* and that therefore age or size *per se* has no influence upon metamorphosis.

The normal tadpole, however, at an age when only the rudiments of limbs are present, possesses a well-developed thyroid. Swingle,[21] working with neotenous bull-frog tadpoles, *i. e.*, individuals in which the metamorphosis is abnormally delayed for one or more years, found that their thyroids were perfectly capable of inducing metamorphosis when grafted into tadpoles of small species. Further he tried the same experiment with the thyroid of the normally neotenous Axolotl and found that it, too, could cause precocious metamorphosis in frog larvae.

Perhaps most remarkable of all is the fact that in permanently neotenous forms, such as Necturus, Hogben and Swingle have independently shown that no amount of thyroid feeding,[11] nor thyroid feeding and grafting, together with pituitary treatment,[21] will bring about metamorphosis. The utmost that has been observed with any perennibranchiate form, as a result of thyroid treatment, is a slight reduction in height of the fin. On the other hand, Swingle has shown that the thyroid of Necturus will produce metamorphosis when grafted on Anuran larvae. It has further been found impossible to produce metamorphosis in Lampreys by thyroid treatment of the Ammocoete larvae.[15]

The first thing that is clear is that the thyroid is not a specific "metamorphosis-producing" agent. In some metamorphosing animals it does, in others it does not produce metamorphosis. Furthermore, recent work of Hogben shows that injection of anterior lobe of the pituitary causes metamorphosis in thyroidless as well as in normal Axolotls, so that the effect of the pituitary upon metamorphosis

may be direct and not, as was previously supposed, exerted solely indirectly by stimulating the thyroid.[13]

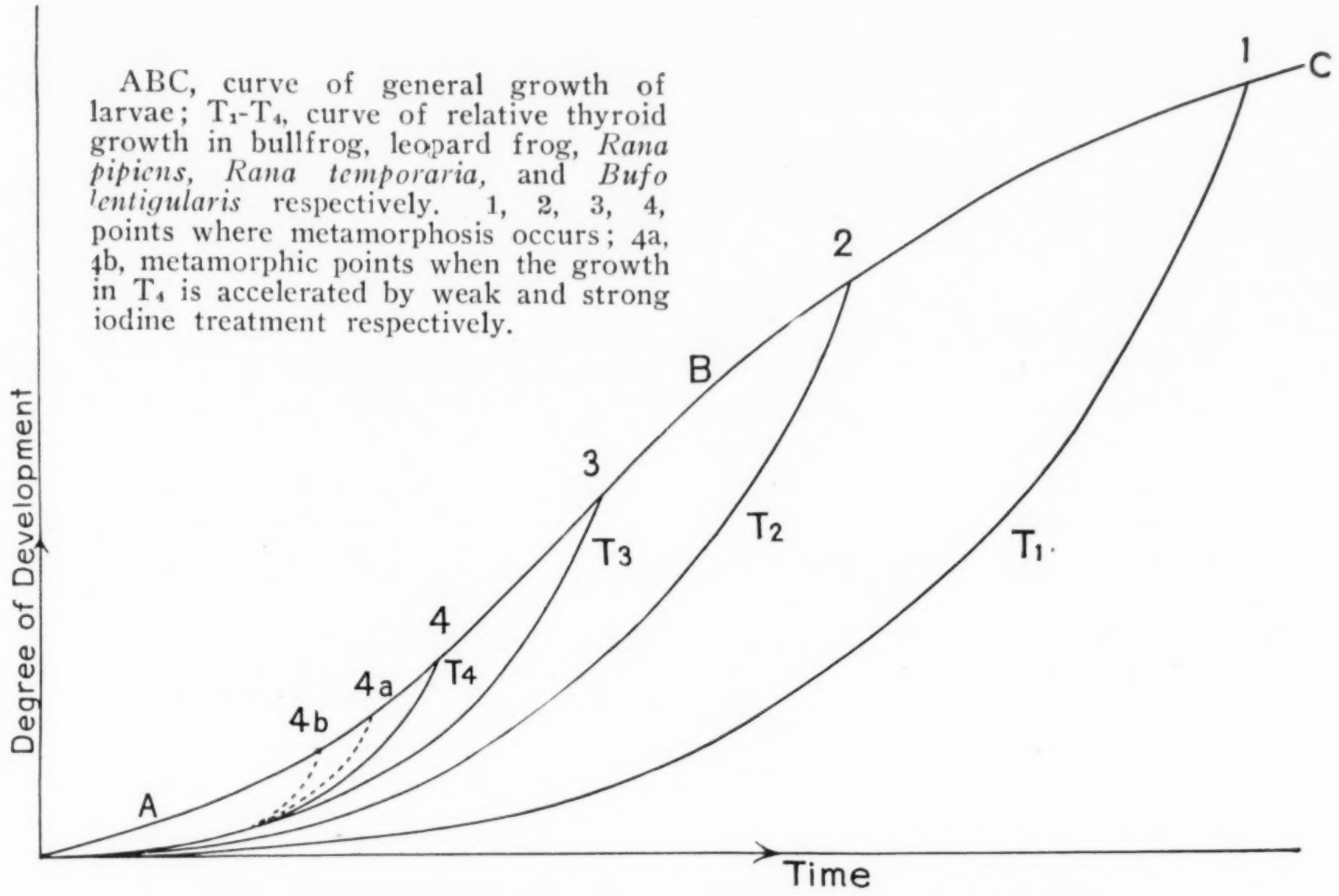
The fact that not only are limbs fully formed before metamorphosis in Urodeles, but that they do not appear to be affected in their growth by iodine treatment,[23] whereas they may be formed quite precociously as the result of that treatment in Anura, shows that the same organ responds in a totally different way in the two groups. The resorption of the tail in Anura, and its non-resorption in Urodela, is a fact of the same order. Our next assumption, therefore, is that metamorphosis is not, in the main, a specific effect of thyroid secretion in the sense that thyroid secretion has a special growth-promoting effect on certain types of organs, but that it is what we have called a general effect upon metabolism, inducing a different internal environment. The larval organization is adapted to one environment, the adult to the other; as the first environment changes into the second, the larval organs can no longer maintain themselves, and break down, just as do the female structures, such as ovary and oviduct, in a female frog which is becoming transformed into a male, in which, therefore, the internal environment favors the growth of male and discourages that of female characters.

It is further clear that, if this be so, we need no longer go to the trouble of postulating a change of function in the thyroid, for we can think of the change as occuring *when a certain relative concentration of thyroid secretion* exists in the organism. In other words, metamorphosis, like sex, is an affair of balance. It is not the absolute amount of thyroid secretion which is at the root of the matter, but the amount of thyroid secretion considered in relation to the amount of certain other substances, or the intensity of other processes. There is therefore a normal threshold value for the amount of thyroid secretion necessary to produce metamorphosis in a given species, but this need not be the same, even when calculated relative to body weight, for different species; and it may be possible to alter this value artificially in any one species. It need not be the same, for it will be exerting its effects *relatively* to other metabolic processes, and these may be different in different species.*

That the thyroid exerts its effects by a special effect on cell metabolism is made probable by the important discovery of Hogben, that injections of anterior lobe of the pituitary will produce metamorphosis even in thyroidless Axolotls.[13] That pituitary as well as thyroid is concerned with increasing basal metabolism, is rendered highly probable by the work of Hill[12] and Benedict and Homans[3].

Let us consider a few facts in the light of these considerations. Uhlenhuth, in a very interesting paper,[22] has shown that in certain Urodeles, which in this regard are probably similar to Anura, metamorphosis is correlated not with growth-rate, but with the attainment of a certain size. At a given temperature this size will be constant, whether the animal is well fed and grows rapidly, or half starved and grows very slowly. We may take this to mean that differentiation and growth of thyroid and of the rest of the body are, as one would expect, bound up together, one affecting the other. He also finds that the "metamorphic size" changes with the temperature; at low temperatures the size is greater (by about 10% in body length). This would imply that the temperature-coefficients for thyroid and general body differentiation are slightly different. It is worth noting that Goldschmidt has found similar temperature effects in his intersexual

* This threshold value refers to the concentration just prior to and at the time of metamorphosis. There is some evidence to show that in adult Anura, the concentration of thyroid hormone decreases again; but, since metamorphosis is irreversible, no morphogenetic processes ensue.


ABC, curve of general growth of larvae; T₁-T₄, curve of relative thyroid growth in bullfrog, leopard frog, *Rana pipiens*, *Rana temporaria*, and *Bufo lentigularis* respectively. 1, 2, 3, 4, points where metamorphosis occurs; 4a, 4b, metamorphic points when the growth in T₄ is accelerated by weak and strong iodine treatment respectively.
Degree of Development
Time
A
B
C
1
2
3
4
4a
4b
T1
T2
T3
T4

FACTORS DETERMINING TIME OF METAMORPHOSIS

FIGURE 11. Metamorphosis may be conceived of as being brought about by differential growth of the thyroid and the body tissues. At first the body tissues develop faster than the thyroid, but later on their rate of development slows down while that of the thyroid increases. Inevitably, then, the curve for body growth and the curve for thyroid growth will cross, and at this point metamorphosis occurs. Metamorphosis, like sex in Goldschmidt's moths, is an affair of balance, but the changes are irreversible and a decrease in thyroid concentration after metamorphosis has taken place does not result in a return to the larva state, or "katamorphosis" as it might be called.

moths; alteration of temperature causes alteration of degree of intersexuality,—in other words, alteration of the stage of differentiation at which the "sex-metamorphosis" occurs.

This matter of differential temperature-coefficient is obviously of importance. What complex effects it may produce in what at first sight appears a simple phenomenon is shown by such work as that of Fenn on phagocytosis.[7]

It is worth noting that this differential temperature-coefficient possibly exerts an indirect effect upon sex in Amphibia. Witschi found that temperature changes brought about alterations in sex-ratio in frogs;[24] and Adler found that in late-fertilized frogs (which, as is well known after the researches of R. Hertwig's pupil, Kuschakewitsch, all become males[16]), the thyroid was abnormally large[1]. This, together with the previous connection between temperature and relative rate of thyroid-differentiation, as shown by alterations of metamorphic size, makes it at least possible that the sex effect of temperature in frogs is connected with an effect upon the thyroid. A good example of the *relative* nature of the thyroid's action is afforded by the fact that the time required for metamorphosis by thyroid feeding in sexually mature Axolotls is longer than in immature specimens[14]. This is also true for pituitary metamorphosis[13]. Apparently the change of metabolism due to maturity, and increased size and age raises what we may metaphorically call the resistance of the larval tissues to metamorphosis.

The reason that the thyroid of frog larvae belonging to large species which do not metamorphose their first year may yet be active when grafted into larvae of other species need not, then, mean that the grafting has in some way altered their function, or that an "excretor substance" is present in the grafted larvae which stimulates the grafts to secrete outwards instead of to store their secretions. It merely indicates that the amount of thyroid secretion in larvae of the slow-metamorphosing species remains relatively too low for a longer time than in the others. It is important to notice that this relative slowness in the amount of thyroid secretion may be brought about in two opposite ways—first by decreasing the relative rate of differentiation of the thyroid, or secondly by altering the activity of those other processes in the body against which the thyroid acts.

Whenever a phenomenon is the result of two opposing tendencies, this double possibility of altering the result will of course be present. For instance, it is well known that the resorption of a malignant tumor may be due to damage inflicted on the tumor or to raising the resistance or general activity of the rest of the organism. In a similar way recent physiology emphasizes the existence of a similar balanced action in certain neuroses.[20]

If we look at our facts in the light of our analogy from sex, we may say that metamorphosis is comparable to consecutive hermaphroditism, and is thus a normal process similar to the abnormal process causing intersexuality in the Gypsy Moth. It is consecutive dimorphism; and is due to the fact that the hereditary constitution of most Amphibia is so constructed that a thyroid is produced only after a certain stage, that it then differentiates relatively more rapidly than the rest of the organism, and that the relative amount of thyroid secretion therefore gradually increases until it reaches the threshold value necessary to bring about metamorphosis. (Fig. 11.)

(To be continued.)

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HERITABLE CHARACTERS OF MAIZE

XII—MEALY ENDOSPERM[1]

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MEALY endosperm is a type of defective seed in which the corneous or "horny" portion of the endosperm is partially or completely lacking. This causes the seeds to be smaller, lighter in color, and soft and mealy in texture. When the corneous endosperm is completely aborted the mature seeds are so soft that they may be easily split apart with the finger nail. The embryo is apparently normal in structure, though somewhat reduced in size. The starch grains when examined under the microscope appear to be normal in size and structure. Because of the greater proportion of starch in the seeds, and the fact that the pericarp attains almost complete development regardless of the size of the endosperm, the mealy seeds have a characteristic dull and shrivelled appearance not readily confused with the character *shrunken endosperm* described by Hutchinson.[2]

Mealy seeds were first observed by Dr. D. F. Jones on a segregating self-pollinated flint ear grown by Dr. E. G. Anderson at Cornell. On account of their resemblance to the partial defectives described by the former in the Journal of Heredity,[3] Dr. Anderson very kindly furnished him with seed from this ear. This was grown in the summer of 1920 and crossed with several other types of defectives. The F_2 generation, grown in 1921, was turned over to the writer for classification and further investigation, together with the data previously obtained by Dr. Jones.

Separating and counting of the kernels from nine selfed ears show this character to be a simple Mendelian recessive. Table I shows the tabulated results from these nine ears.

TABLE I.

Ear No.	Normal	Mealy
277	149	46
277—1	190	58
277—2	149	46
277—1—1	256	65
277—1—2	209	59
277—1—3	134	43
277—1—4	166	52
277—1—5	187	78
277—1—6	168	54
Total	1608	501
Expected 3:1	1582	527
Deviation	+26	—26

It was impossible to cross this character directly with other defectives on account of the difficulty of obtaining any of these types in a homozygous condition. However, when a number of segregating plants were crossed, all of the F_1 seeds were normal. If the two types of defectives are genetically distinct we would expect to get in the second generation four kinds of ears, as follows:

1. Ears not segregating.
2. Ears segregating partial defectives.
3. Ears segregating mealy defectives.
4. Ears segregating both types.

[1] contribution from Bussey Institution, Harvard University.

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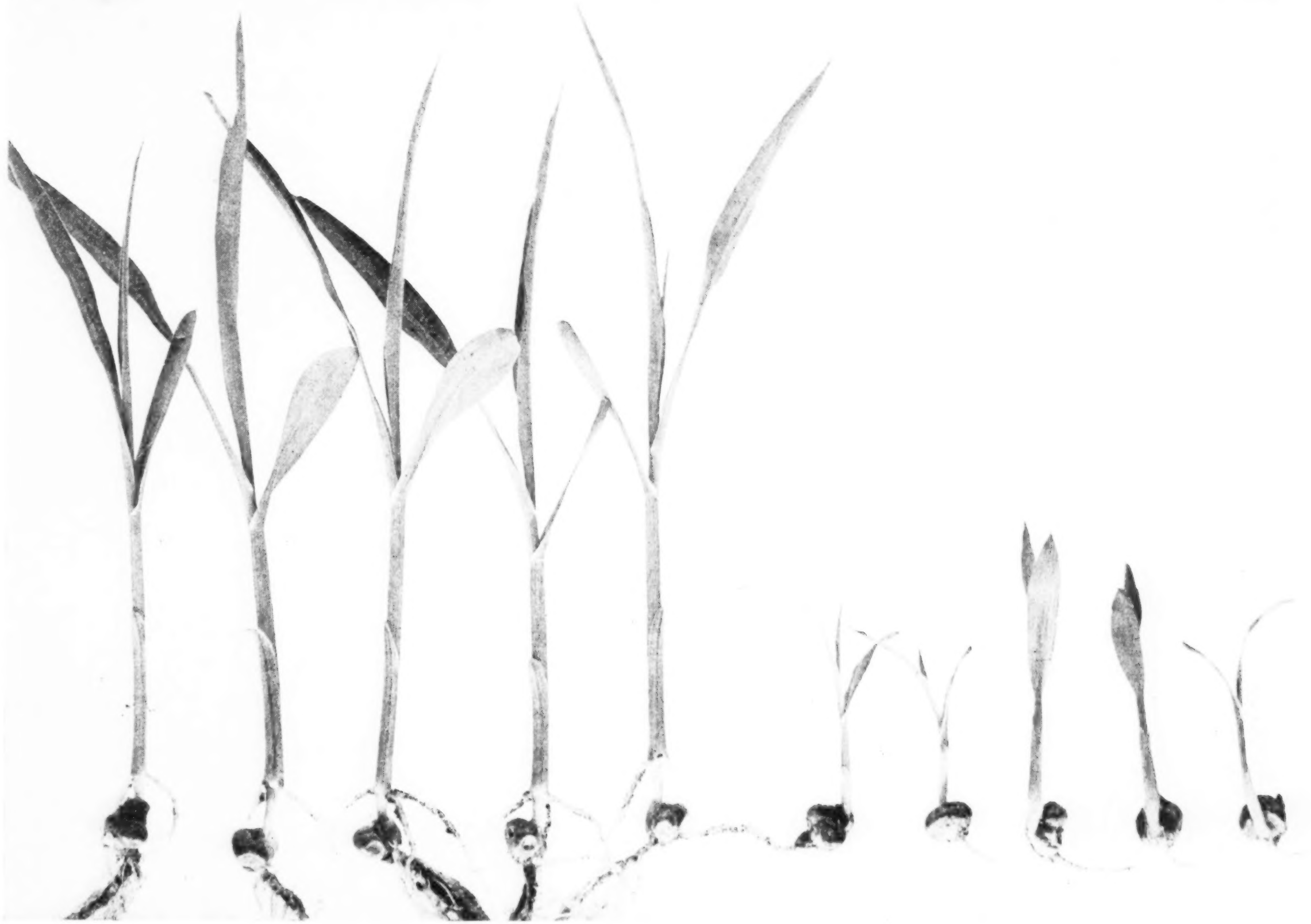
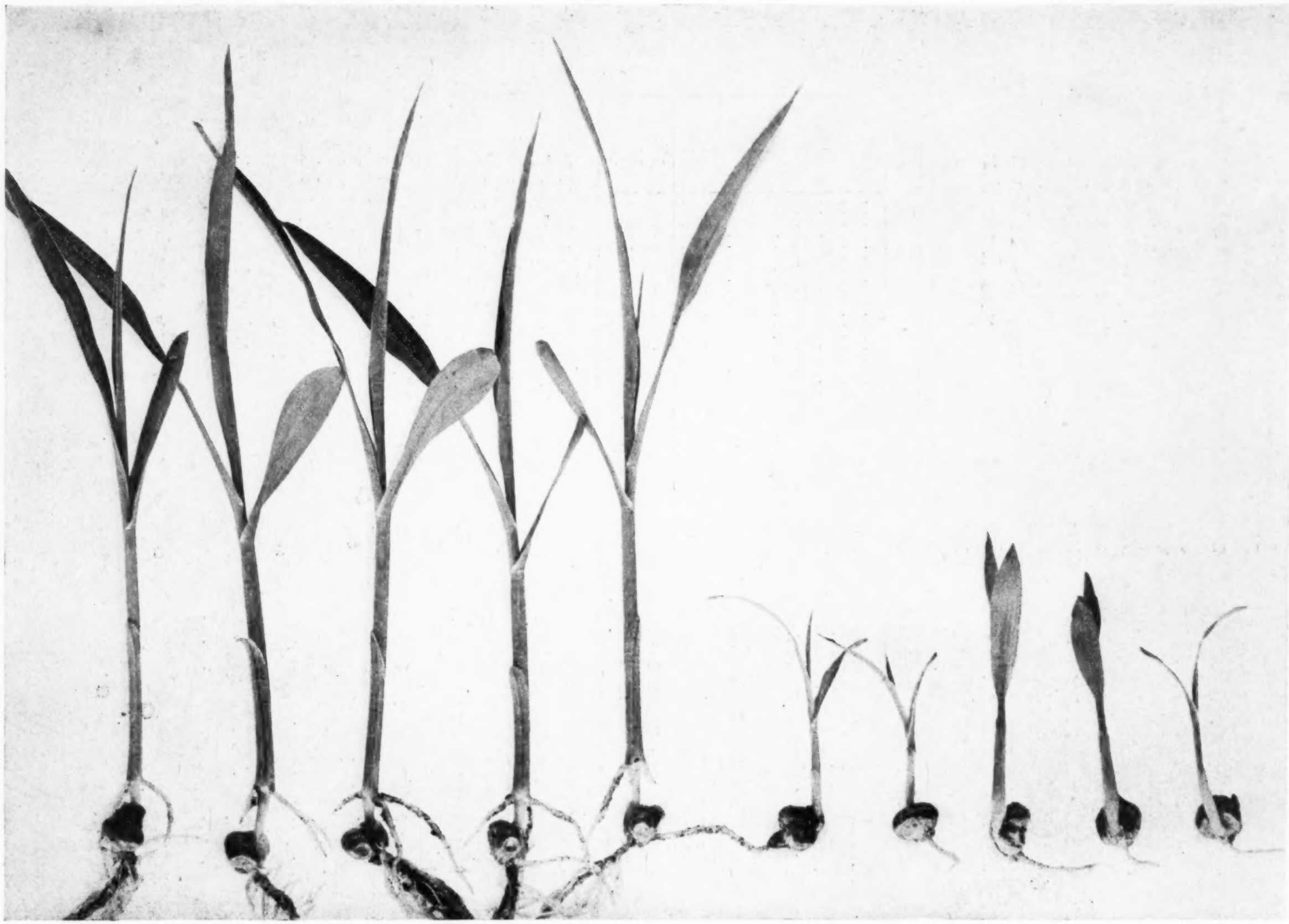


A LETHAL FACTOR IN MAIZE

FIGURE 12. Mealy endosperm acts as a lethal factor because the seedlings from mealy seeds (right) are very small and weak as compared to the normal, and seldom survive.

MEALY ENDOSPERM "ON THE COB"

FIGURE 13. The mealy seeds are somewhat smaller and lighter in color than the normal seeds on the same ear. Because of the phenomenon of double fertilization in maize, the endosperm as well as the embryo is of hybrid origin, one fertilized egg nucleus producing the embryo, and two others the endosperm. Therefore the results of crosses made to study inherited defects in the endosperm can be read directly from the ear without the necessity of raising a second generation.



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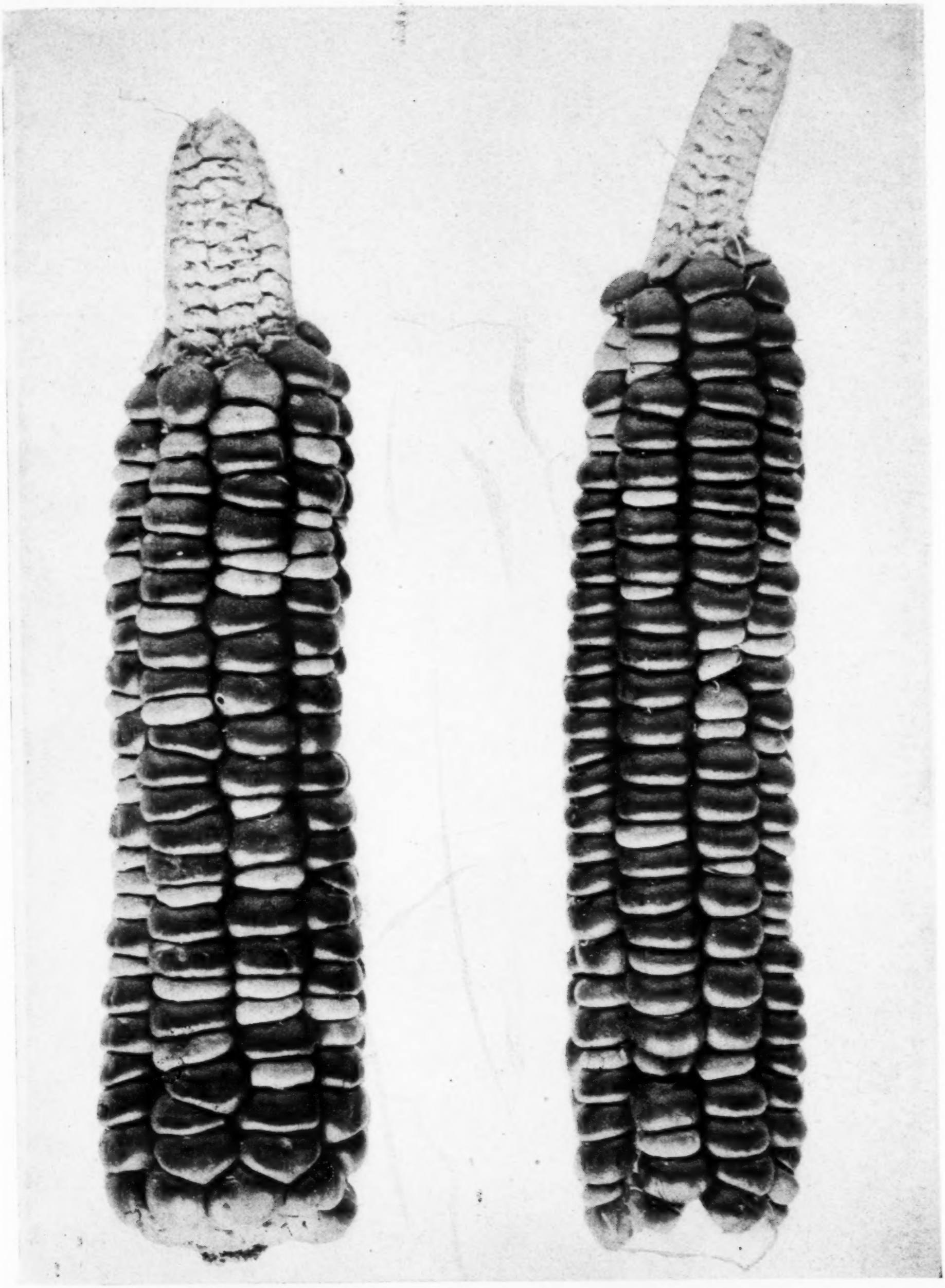

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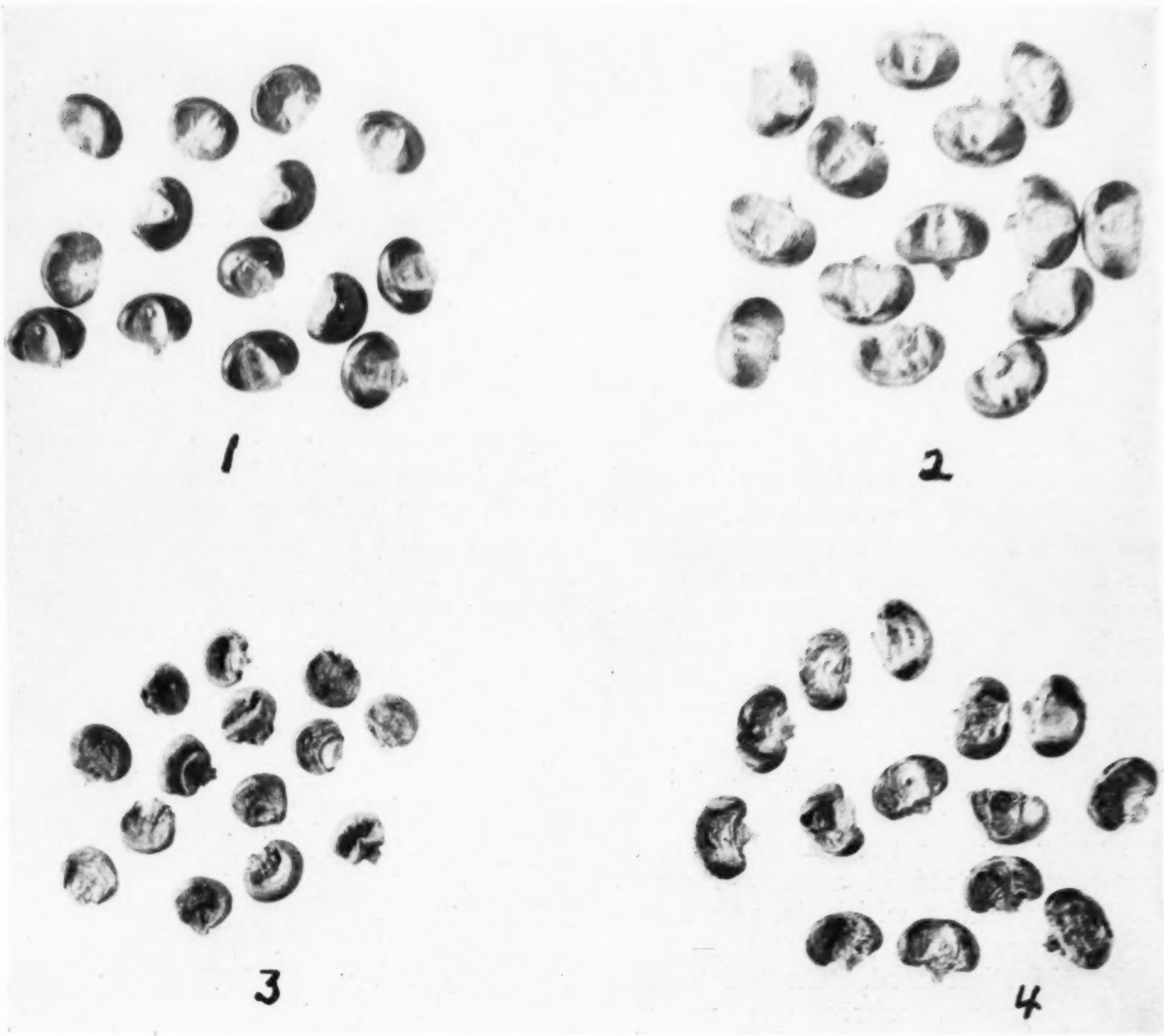
LINKAGE WITH CHLOROPHYLL DEFICIENCY

FIGURE 14. The seedlings at the right were grown from mealy seeds and those at the left from normal seeds on the same ear, which was also heterozygous for white seedlings. Nearly all of the normal grains produced green plants, and a large part of the seedlings from mealy grains were white. The exceptions indicate that the condition represents a case of true linkage, and not distinct expressions of the same germinal factor. If the two characters were genetically identical and owed their existence to the same factor, we would not expect them ever to be separated.



NORMAL AND DEFECTIVE SEEDS

FIGURE 15. The mealy seeds (3) resemble very closely another type of defective seeds (4), but the two are entirely distinct genetically. Normal seeds are shown at (1) and (2).

Table II shows that all four kinds of ears were obtained and indicates clearly that the two defectives, although resembling each other rather closely, are genetically distinct.

TABLE II.

Ear No.	Normal	Partial defectives
1	208	71
6	248	86
11	111	37
Total	567	194
Expected 3:1	571	190
Deviation	−4	+4

Ear No.	Normal	Mealy defectives
3	212	85
4	212	86
7	237	49
Total	661	220
Expected 3:1	660	221
Deviation	+1	−1

Ear No.	Normal	Both types
2	187	108
5	169	117
8	160	105
Total	525	330
Expected 9:6	513	342
Deviation	+12	−12

Ears 9 and 10 not segregating.

On account of the phenomenon of double fertilization in maize, the F_2 endosperm develops on an F_1 ear.[4] The F_1 plants are, as a rule, extremely vigorous and the mealy seeds when borne on a hybrid plant are appreciably altered in appearance. There is a partial development of the corneous endosperm and the seeds are often almost normal in size. The white portion of the endosperm showing through the incomplete corneous layer gives the seed a dull and mottled appearance. Seeds of this description are often found on ears not carrying the factor for mealy, especially when the ear has ripened prematurely. Separation of mealy seeds after crossing is consequently more difficult and less accurate.

It appears that the genetic factor for mealy does not specifically inhibit the formation of corneous endosperm. It simply arrests the development of the growing seed at a certain stage. The horny layer which is apparently formed later in the process is thereby ordinarily eliminated. On the hybrid plant, however, where the various stages follow each other in more rapid succession, the corneous endosperm has an opportunity to become partially developed before the factor for mealy can operate. Just how this character would manifest itself in floury types of corn in which the hard endosperm is completely lacking is not known, but it would presumably result merely in a loss of size.

A Lethal Factor

Practically speaking, mealy is a lethal factor because under ordinary field conditions the mealy seeds will not grow. When planted in the greenhouse under optimum conditions of temperature and moisture the recessive seeds show a germination of twenty per cent. The seedlings are very small and weak, as shown in the illustration, and survive but a short time. Seeds from F_1 ears have a higher germination and produce more vigorous plants, but even these ordinarily live only a few weeks.

Linkage Relations

The linkage relations of this character were discovered quite by accident. In one of the F_1 ears the mealy seeds were so well developed that it seemed feasible to plant a row of them in the field in order to get the character in a homozygous condition. A week later when the seedlings had emerged this row was easily the most conspicuous feature of the entire field. All of the plants were albinoes except one. This solid row of white seedlings in sharp contrast to the rows of green ones on either side made a very striking demonstration of linkage.

The other ears of this cross were later tested for linkage and the data are given in Table III. Figures for only those ears segregating both mealy and white seedlings are given. Since only part of the seeds were planted and since the germination was never perfect, no attempt has been made to reduce the figures to actual linkage values and only the percentage of each type are here given. This provides but an indication of the linkage values, but in cases where it is impossible to back-cross the hybrid with the double recessive, one cannot arrive at more than a rough approximation.

TABLE III.

Ear No.	Normal		Mealy	
	Green	White	Green	White
2	126	15	30	20
4	158	19	23	19
5	79	19	0	19
7	130	20	1	39
8	119	1	28	32
Total.	612	74	82	129
Percentage	89.2	10.8	38.9	61.1

[4] WEBER, H. J. Xenia, or the immediate effect of Pollen in Maize. *Bulletin 22*, Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture. 1900.

Of the normal seeds planted only 10.8 per cent. produced white seedlings, while 61.1 per cent., or almost six times as many, of the mealy seeds developed into albinoes. If the characters were inherited independently approximately 25 per cent. of both types of seed should produce white seedlings. Clearly there is some definite relation between mealy endosperm and this type of chlorophyll deficiency. There is a possibility that the relation may be physiological rather than a case of true linkage; that both abnormalities are merely the expression of the same physiological condition. The fact that normal ears of this strain often segregate for white seedlings and that mealy seeds sometimes produce only green plants seems, however, to preclude this possibility. Further tests are now being made to determine more definitely the relation that exists between these two lethals.

The Freudian Obsession

MYSTICISM, FREUDIANISM AND SCIENTIFIC PSYCHOLOGY, by KNIGHT DUNLAP. C. V. Mosby Co., St. Louis, Mo.

Prof. Dunlap in this condensed volume fights the battle of common sense as well as that of scientific psychology. He does it simply and effectively. The book shows thorough acquaintance with modern psychology in its writer, but does not necessarily demand such acquaintance in its readers. The book has three sections. The first of these discusses the varied phenomena of religious mysticism, especially where such mysticism passes over into the extremes that become more or less completely hysterical. The second considers even more at length these same hysterical exaggerations in their grosser manifestations of extreme Freudianism, psychoanalysis, christian science, etc. The third section of the book develops succinctly and clearly both the methods and the results of true scientific psychology in its study of mental phenomena as contrasted with the methods of these scientific heresies. We wonder whether it was necessary to include so many of the excessive and offensive exaggerations of Freudianism as are here quoted. A very few such samples would seem sufficient to develop all the distrust and the disgust which was necessary. However, if revelation of the erotic hysteria of such pseudoscience were needed, it is here abundantly provided.—*R. E. C.*

Books Received

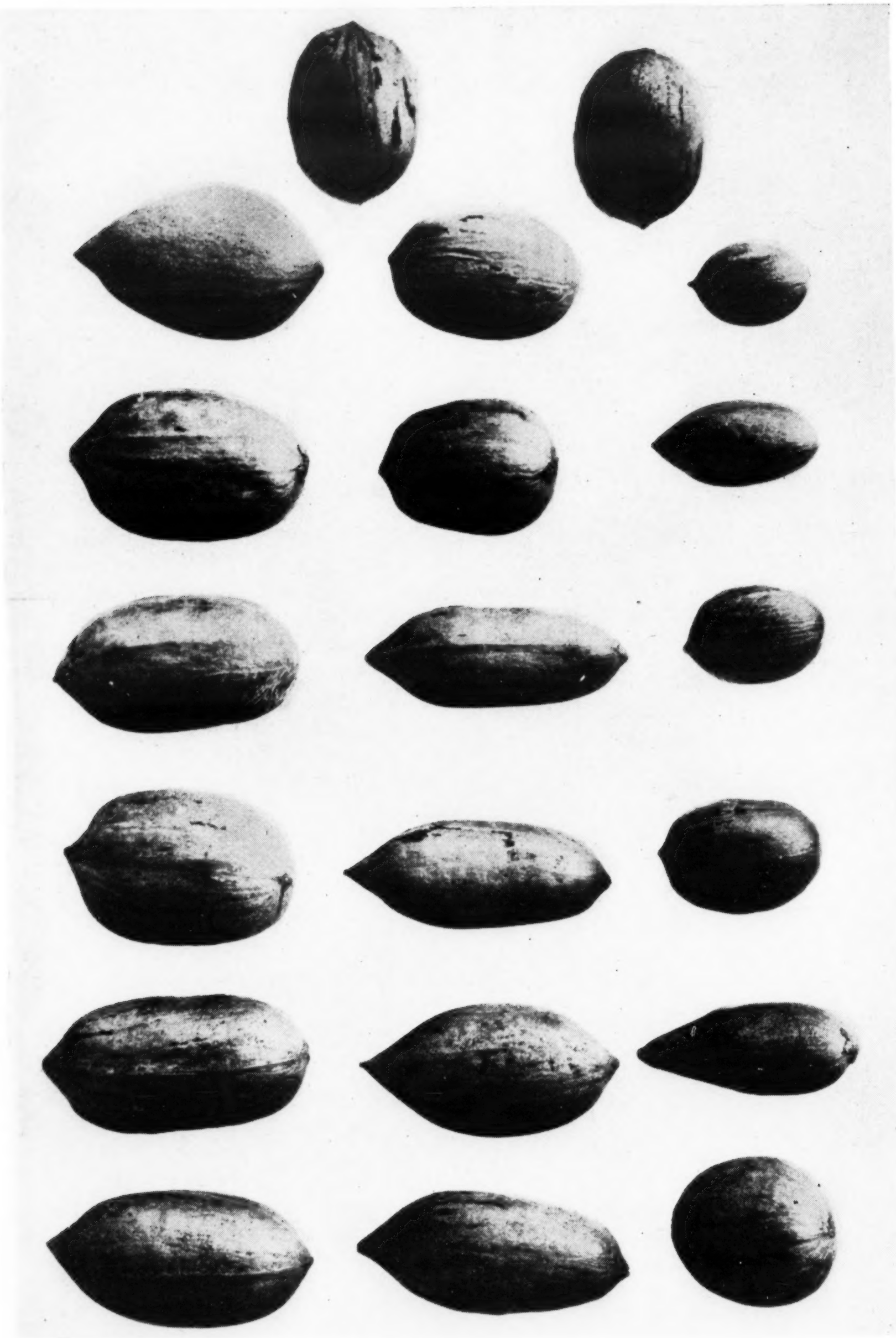
The Biology of Death, by RAYMOND PEARL. J. B. Lippincott Company, New York. 1922.

Human Life as the Biologist Sees It, by VERNON KELLOGG. Henry Holt and Company, New York. 1922.

The Physiology of Twinning, by HORATIO HACKETT NEWMAN. The University of Chicago Press, Chicago. 1922.

Social Change, by HENRY FIELDING OGBURN. B. W. Huebsch Co., New York. 1922.

Glands In Health and Disease, by BENJAMIN HARROW. The Macmillan Co., New York. 1922.



PECAN SIBLINGS

FIGURE 16. The two nuts at the top of the picture are from the parent tree, the original San Saba. The others are from eighteen seedling trees raised from a single season's crop of the mother tree. Each represents the type of the nuts of the tree from which it was taken, as all nuts from a single pecan tree are remarkably alike. Only four of the seedlings were considered of sufficient value to propagate and two were introduced as named varieties.

VARIATIONS IN PECANS

F. W. Brison

A. and M. College, College Station, Texas.

FEW plants show such a wide variability as the pecan when it is reproduced from seed. This is so great as effectually to prevent the propagation of improved varieties by seed, though it offers the pecan grower a good opportunity for the introduction of new varieties by selection. New varieties obtained can be perpetuated indefinitely by budding and grafting. From the breeder's point of view this great diversity of the sexual progeny of pecan trees is very fortunate, as it is only through the occurrence of variations in any plant that further improvement within that species is possible.

The Pecan Crop

Every section of the country has a crop or enterprise of which it is proud. The time is probably not very remote when the South will boast as loudly of her pecan industry as she does now of her cotton, and pecans will be as widely advertised as the walnuts of California. The pecan is indigenous only to certain parts of the southern United States and a small section of northern Mexico. Dean Kyle, of the Texas A. and M. College, declares that Texas is the real home of the pecan; and Texas alone has more native pecans than all the other states combined.

In 1919, 16,755,421 pounds of pecans valued at $3,698,233 were produced in Texas. Probably nowhere else in the world does nature, unaided by man, produce a crop, ready for the market, of as great a money value. Within the last twenty years large areas have been planted to improved varieties of pecans in Georgia, Alabama, Mississippi, Florida, and Louisiana; and these states are now leading in the production of improved varieties.

The pecan is monoecious, the staminate flowers or catkins being borne on wood of the preceding season's growth, while the pistillate flowers are borne on wood of the current season's growth. The pollen grains are carried from the catkins to the pistils by wind primarily, and by gravity. Naturally, then, a high percentage of cross pollination will take place. It is believed that under the most favorable climatic conditions, viable pollen grains may be carried a distance of three or four miles. The pecans produced by one tree are the result of the union of the sperm cells of pollen grains from many different trees with the egg cells of the mother tree. Consequently the result of each fertilization is apt to vary in one or more respects from the result of all other fertilizations, owing partially to the difference in the paternal influence as well as to the difference due to segregation of characters in the production of the egg cells by the mother tree. The shell of a pecan is purely maternal tissue, and so similar are all the nuts produced by a variety that trees, the variety name of which is not known, can be identified by the nuts they bear.

Production of New Varieties

Self- or close-pollination of pecans for seed purposes is frequently recommended. It is no doubt a good practice but it does not insure an exact reproduction of the pecans planted because of the heterozygous character of the pecan; it only increases the chances of getting a good tree from the seed planted. The pecan tree is slow in coming into bearing, requiring from five to twelve years from the time a nut is planted until the tree produced from it bears seed. Any attempt to produce

a pure line by self-pollination will necessarily have to be extended over a very long series of years. Most of the so-called "improved" varieties of pecans were originally found growing wild and have been propagated asexually ever since.

On exhibit at the Horticultural Show of the A. and M. College of Texas in 1922, was a display of thirty-six distinct types of pecans, produced by thirty-six different trees that were grown from seed, all produced the same year by a single mother pecan tree, the original San Saba. Of the thirty-six samples only four are considered as good as, or better than the mother tree. Two of them, the Texas Prolific and Western Schley, have been introduced as named varieties. In size of nuts there is a rather uniform gradation from those as large as beans to those over two inches in length. No correlation between size of nut and thickness of shell is evident. Some of the larger nuts have very thin shells, while some of the smaller ones have extremely thick ones, and *vice versa*. The accompanying picture gives only a inadequate idea of the difference between these varieties, since size and shape are the only qualities which show up well in pictures. There are also marked differences in flavor, proportion of kernel to shell, readiness with which kernel separates from shell, and habits of growth of the tree from which the nuts came.

The man who planted the pecans and expected the progeny to be exact reproductions of the San Saba variety convinced himself by this demonstration that propagation of pecans by seed is not a reliable method; and he is now perpetuating his standard varieties by budding and grafting. He continues to plant pecan seeds only in the hope of obtaining chance seedlings which will be good enough to introduce to the public as named varieties.

Thus it will be seen that the propagation and improvement of the pecan is governed by the very same principles which govern the apple, pear, and other fruit and nut trees. There is this one difference, however: the development of the pecan is so recent that there still remain greater opportunities of finding superior seedlings than is the case with the fruits and nuts which have been longer cultivated by man.

The Doctrines of Sidis

NERVOUS ILLS, THEIR CAUSE AND CURE, by BORIS SIDIS, M. D. Pp. 379; price $3. Boston, Richard G. Badger, 1922.

In this volume Dr. Sidis gives an extended popular presentation of his thesis that mental and nervous diseases are due to perversions of the fundamental instincts of self-preservation and fear. He describes the satisfactory results of his treatment of such diseases by the hypnoidal state. Two chapters devoted to heredity and eugenics respectively are superficial and bigoted. The chapter discussing eugenics is in considerable part made up of a diatribe against eugenists which the author evidently admires enough to quote verbatim (but without citation) from one of his earlier volumes. Numerous interesting case histories are presented.—*P. P.*

STERILITY IN LILIES

A. B. Stout

New York Botanical Garden, New York City

THE tendency of many species of lilies to produce seed irregularly, sparingly, or even not at all, is well exemplified in the old familiar Tiger Lily of our flower gardens. This species has been in cultivation in Europe since 1804; it thrives and blooms abundantly over a wide area; it has been observed in cultivation and also apparently wild in its native home (China and Japan) by persons interested in discovering whether fruits were formed. Yet the author is aware of only two references to the pods and seeds of this species, and the accuracy of these is somewhat doubtful. On the other hand, its fruitlessness has repeatedly been observed wherever it has been grown. The Tiger Lily is one of the most striking examples that can be cited of a plant which blooms in abundance but is propagated only by vegetative means.

The Law of Compensation

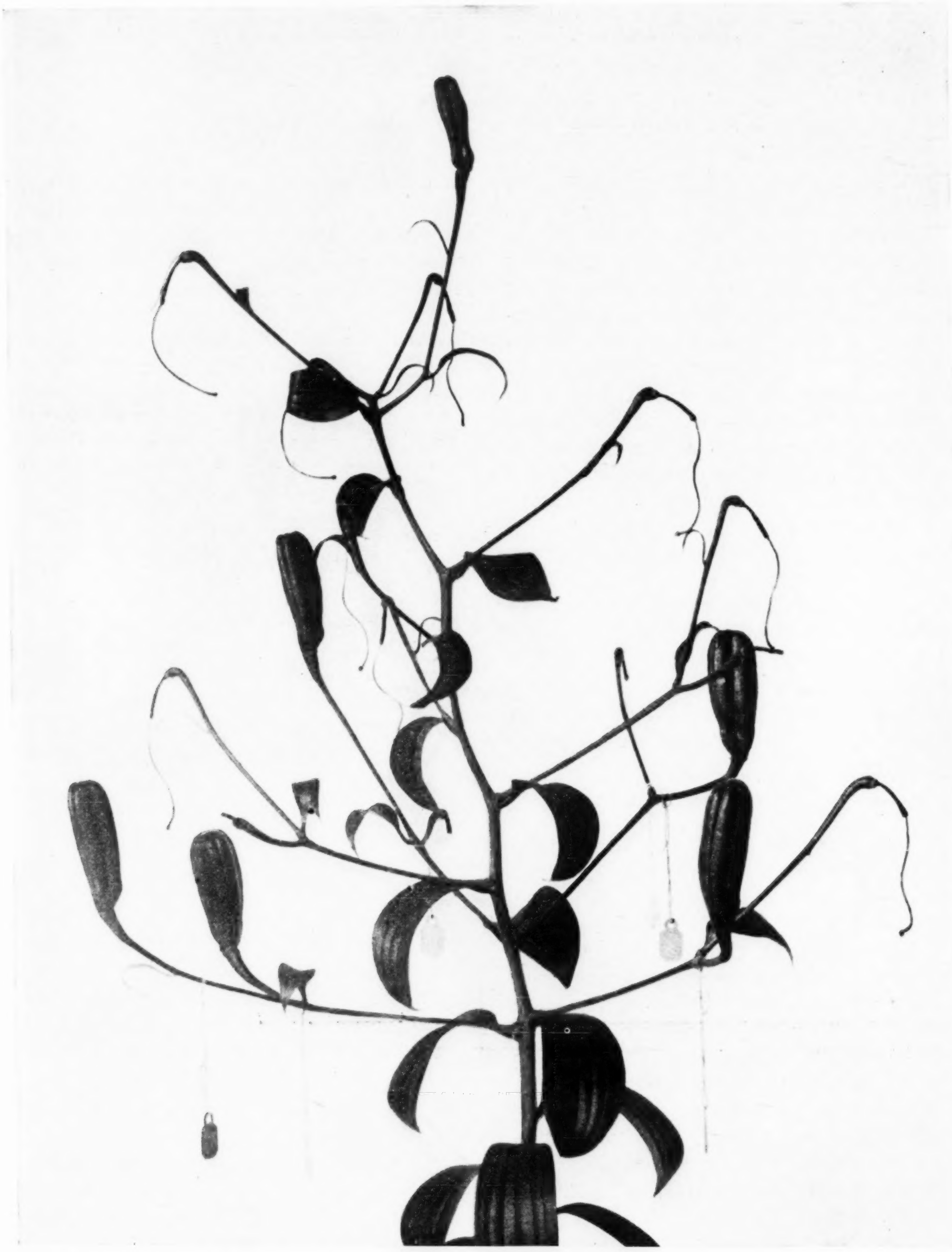
A ready explanation has long been offered by gardeners and botanists for the condition of sterility found in such plants as the lilies. It has been generally believed that they are physically unable to develop seeds because the bulbs and bulblets use the available food. The tiny embryos were assumed to be virtually starved to death. This explanation of the condition has seemed so obvious and so correct that it has received the sanction of the most critical authorities, and is stated in Darwin's law of compensation and in Goebel's law of correlation. But this simple and apparently very satisfactory explanation we now know to be entirely wrong, at least in its application to the condition of sterility in the lilies. Obviously the best evidence of the truth of this statement is the fact that these usually fruitless plants have been shown to be fully able to produce capsules and seeds. Such evidence is in most cases readily obtained.

Sterility Due to Incompatibility of Pollen

For a period of about fifteen years Focke persisted in attempts to obtain seed of *L. bulbiferum.* He secured bulbs from various parts of northern and western Germany and made many cross-pollinations of their flowers, but obtained at best only a few poor capsules. Finally, bulbs were secured from Switzerland and with the use of pollen of plants grown from them pods and seeds in abundance were matured on the hitherto fruitless plants.[1]

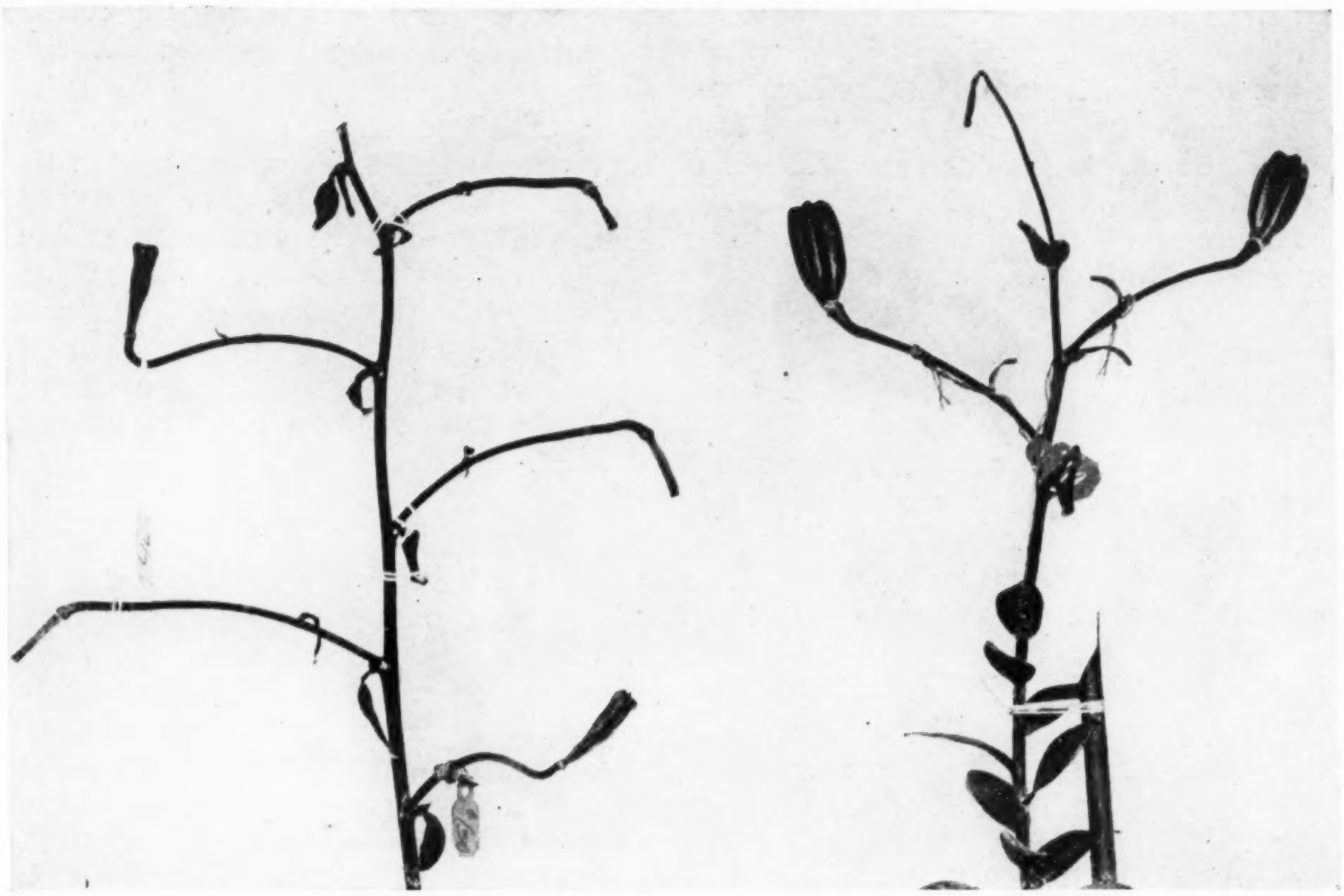
The writer has had much the same experience with other species of lilies. A fine large cluster of *L. croceum,* all descended from a single bulb, growing in the New York Botanical Garden, completely failed to set seed for eight consecutive years. The numerous flowers that appeared each year were self- and cross-pollinated, but there was never even a slight enlargement of any of the ovaries. In 1921, plants of *L. elegans* bloomed at the same time as the cluster of *L. croceum,* and their pollen was used in pollinations. Fine large pods then developed, and these contained many viable seeds. In 1922 these plants of *L. croceum* also yielded pods and seed by cross-pollination with another strain of the same species. Hence these plants were fully able to mature fruit, and their pollen was likewise able to function in certain reciprocal crosses.

[1] Several papers by W. O. Focke bearing on phenomena of self-incompatibility were published between the years 1887 and 1893.



SELF-STERILE, BUT PRODUCING PODS WHEN CROSSED

FIGURE 17. This plant of *Lilium speciosum* is fully self-incompatible, but yields fine pods to pollen from certain other plants of the same species, which presumably indicates their origin from different seeds. This, of course, does not insure compatibility, as plants known to be of distinct seed-origin are often incompatible. Self-incompatibility is also met with when large plantings of fruit trees of the same variety are made. Unless two or more distinct varieties of different seed origin are inter-planted, no fruit is produced.



SEED OF THE SEEDLESS TIGER LILY

FIGURE 18. While the Tiger Lily has thus far failed to yield pods to intra-specific pollination, many have been obtained to pollen of *L. maximowiczii,* as is proved by the two fine pods on the plant at the right. To the pollen of *L. warleyense* only imperfect pods were developed, as shown in the two upturned but partly developed pods on the left. The Tiger Lily is evidently able to produce seed and its usual sterility is due to physiological incompatibility of the pollen used, and is not in any way connected with the fact that the plant habitually reproduces by means of bulbs.

In an effort to discover compatible fertilizations that would produce seed on the Tiger Lily, bulbs of this species have been secured from widely separated localities, some even coming directly from apparently wild plants in China. All plants grown from these have, so far as tested, failed to yield fruits either by self-pollination or by cross-pollination between the different strains. Capsules also failed to form when pollen of such species as *L. canadense, L. supurbum, L. henryi, L. speciosum, L. auratum,* and *L. humboldtii* was used. To pollen of *L. warleyense,* the ovaries of the Tiger Lily began to enlarge and become upturned (see Fig. 18), but the capsules did not develop fully and yielded no seeds. But when pollen of *L. maximowiczii* was used fine pods were readily obtained (see Fig. 18). Potted plants, plants grown in the open, old plants of vigorous vegetative growth, and plants from bulblets blooming for the first time have all produced fine pods from the flowers thus pollinated. Yet on these same plants complete failure resulted from all attempts to produce seed by self-pollination.

It is clear that these usually sterile plants are able to form fruit and seeds and that their pollen is potent, provided there are compatible relations in fertilization. The bulb and the bulblet-forming habits of growth, and of vegetative propagation do not render seed production impossible. The sterility is that of physiological incompatibility in fertilization, a well-marked type which is also seen in numerous species that naturally reproduce exclusively by seeds, and is by no means peculiar to plants that reproduce vegetatively.

In the course of experimental studies with species of Lilium now in progress at the New York Botanical Garden, controlled pollinations have been made for plants of twenty-eight species. In every species thus far studied seed production is decidedly limited by incompatibility in fertilization.

The phenomena of incompatibility are well illustrated by the results obtained with *L. regale,* a splendid and beautiful lily recently introduced from China. Of the ten plants tested, nine were self-incompatible and one was self-compatible. Cross pollination between plants sometimes succeeded and sometimes failed. The same sort of results were also obtained with plants of *L. speciosum, L. candidum, L. henryi, L. parvum, L. tenuifolium, L. humboldtii, L. kelloggii, L. warleyense, L. longiflorum,* and *L. auratum.*

No capsules have yet been obtained on plants of *L. hansonii, L. parryi, L. maximowiczii,* and *L. chalcedonicum,* but in all cases except that of *L. hansonii,* only a few plants have been tested, and these were all obtained from a single source.

Cross-Incompatibility

It is to be noted that crosses between different plants of a species in which there is self-compatibility are also frequently incompatible. One is, however, not at all certain that any two plants of a variety of lily are really of different seed origin, for they both may be the daughter bulbs of a single parent plant, and thus belong to a single clone. If the original plant grown from seed was entirely self-compatible, then one may expect the members of the clone to fail to set seed in crosses. The condition is similar to that encountered in fruit-growing, when an entire orchard of a self-incompatible variety of apple or cherry fails to set fruit unless proper cross-pollination with another variety is provided for. Without doubt it is often the extensive vegetative propagation of a single self-incompatible plant that makes it difficult to secure compatible crosses from apparently different plants of certain varieties of the day lilies and the true lilies.

Seedlings of *L. longiflorum* have been grown to the flowering age in the course of the studies here reported. Many of these were self-incompatible, a few set seed with their own pollen, and many crosses with other plants failed. Such ranges of variation in regard to the compatibilities of sister plants of seed origin are very common in many species.

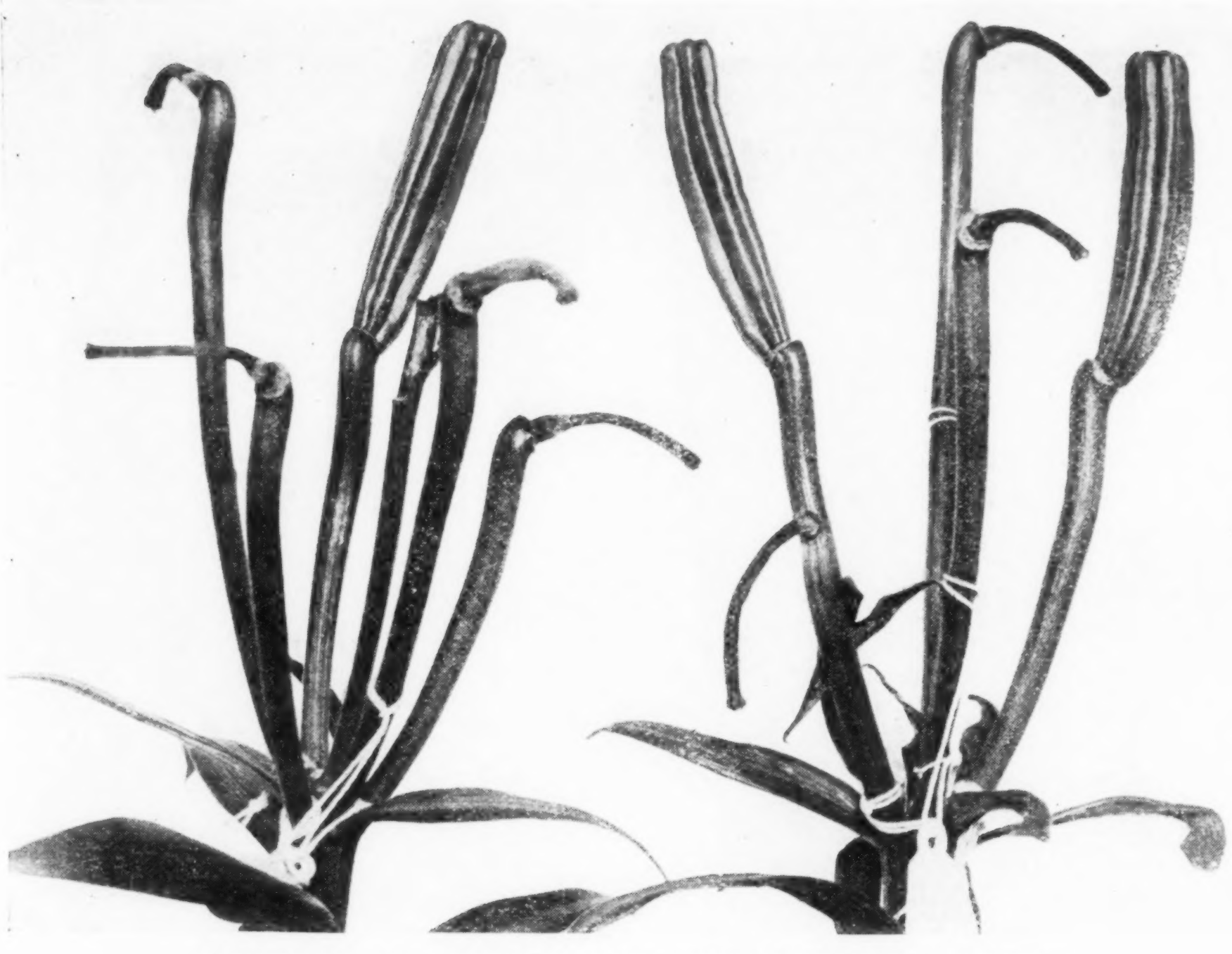
Other Types of Sterility

There are other types of sterility in the lilies besides that of incompatibility. In certain hybrid varieties. *L. batemanniae,* for example, there appears to be complete impotence, a type of sterility that is very characteristic of hybrids; the spores, both in pistils and stamens, are aborted and functionless in any relation. A one-sided abortion characteristic of intersexes has also been noted in at least one species.

How to Obtain Seed

The principal condition limiting seed production in the lilies is that of incompatibility. When seed is desired from plants that are yielding no seeds because of this condition, it is simply necessary to obtain other stocks of the same species and interplant so that cross-pollination may be effected by insects, or by hand. If the new stock is cross-compatible, seed will readily be produced, but if it is not, seed will not be formed until stock which is compatible is secured. Usually compatible clones may readily be obtained, and often a single planting of commercial bulbs contains such a mixture of stocks, but for certain species and especially for *L. tigrinum, L. hansonii,* and *L. candidum,* it seems somewhat difficult to secure compatible fertilization.

One of the principal sources of failure in establishing a planting of lilies in one's garden is the poor physical condition of bulbs when received. Especially is this true when bulbs are imported. In many species the dormant



RESULTS OF POLLINATION ARE QUICKLY EVIDENT

FIGURE 19. Both of these plants of *L. longiflorum* are self-incompatible and four crosses with other species likewise failed. The three growing pods are from other more successful crosses. The photograph was taken about two weeks after the last pollination was made.

period is very short or is entirely absent. With the death of the top there is usually continued development of the daughter bulbs, and growth of feeding roots. Without doubt the best means of securing healthy and vigorous bulbs, of many species at least, is to grow them locally either from seed or by vegetative propagation, and to transplant so that the bulbs are only out of the ground for a short time, when they are most nearly dormant.

Such excellent varieties as the Easter Lily, the Madonna Lily, Henry's Lily, the Lance-leaved Lily (*L. speciosum*), and the Regal Lily are readily grown from seed. Frequently blooms may be had on seedlings in two years—certainly they may be had in three years. The growing and breeding of lilies from seed presents many interesting possibilities, not only to the commercial growers of bulbs but to the amateur gardener as well.

In lilies the bulb habit of growth does not in the least affect seed production. To obtain seed one must either grow self-compatible plants or grow strains that are cross-compatible. When this is done, seed in abundance may readily be obtained except in the relatively few cases of impotence from intersexes or hybridity.

SELF-STERILITY IN CHINESE CABBAGE

YOICHI KAKIZAKI

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SELF-STERILITY, in a higher or lower degree, is a characteristic quite common to the plants which bear hermaphroditic flowers and yet are habitually cross-pollinated. Plants of this kind show normal fertility under the natural conditions of flowering, but the amount of fruit is greatly reduced when they are self-pollinated artificially. Such seems the case in grasses, clovers, crysanthemums, sun-flowers, some species of Crucifiers, and a number of other genera. A very fine example of self-sterility is seen in Ulrich's experiment with rye.[1]

This characteristic of the plants mentioned above makes it very difficult for plant breeders to obtain self-fertilized seed of these species, especially in case such seed is wanted in large quantities. Consequently it is interesting and important to study the matter more exactly and to search for a method by which such seed can be produced with greater ease. Bearing this in mind, the author tried an experiment last spring with Chinese cabbage, or *Pe-tsai,* in order to determine the effect of various modes of artificial pollination on seed bearing.

Under natural conditions almost every flower of *Pe-tsai* gives rise to a normal pod, with the possible exception of a few terminal ones on each inflorescence. Therefore, it may be assumed that practically all the flowers experimented with would have been fertile under normal conditions. With this fact in mind, five different modes of artificial pollination were applied, viz:

(a) Flowers covered with paraffin bags, but not pollinated artificially.

(b) Flowers pollinated artificially with pollen of the same flowers.

(c) Flowers pollinated with pollen from different flowers in the same inflorescence.

(d) Flowers pollinated with pollen from different inflorescences on the same plant.

(e) Flowers pollinated with pollen from different plants.

The following remarks also must be made as to the technique of the experiment: (1) All of the flowers under control, whether used as male or female in the cross, were covered with paraffined bags before blooming in order to protect them from fertilization by pollen-bearing insects. (2) Those treated with pollen from other flowers (c, d, e) were not emasculated, in order to avoid the experimental errors which might have been caused by faults of the operation. In doing so it was assumed that ovules of a flower would be more readily fertilized by pollen from other flowers, especially that from different plants, than with its own pollen; in other words, the pollen of a flower would actually be more or less handicapped in competition with that from different flowers or plants. (3) After pollination, the flowers were kept under the paper covering for a few days. This treatment did not seem injurious to the development of the pods, because it was found that there was no essential difference in fertility between the flowers which were artificially pollinated with pollen from different plants, and those left to natural cross-pollination.

[1] ULRICH, K. Die Bestaübung und Befruchtung des Roggens. *Inaug. Diss. Halle,* 1902.

POLLINATION IN PE-TSAI CABBAGE

FIGURE 20. On the left (1) are the pods obtained from eleven flowers treated with pollen from the same flower. Next (2) is the single pod obtained when six flowers were treated with pollen from another flower on the same branch. At (3) are shown the pods obtained from fifteen flowers treated with pollen from another branch of the same plant; while on the right are the seven pods obtained by cross-pollination of seven flowers with another plant of the same variety. To self-pollination *pe-tsai* cabbage flowers yielded only about five per cent of perfect pods, whereas ninety-six per cent were obtained by cross-pollination. Apparently there is considerable variation in the extent of self-sterility in different plants, and by selection it may be possible to develop strains that will be nearly one hundred per cent self-fertile.

Discussion

Results of the experiment are shown in the accompanying table.

The flowers pollinated with their own pollen (b), those pollinated with that from different flowers in the same inflorescence (c), and those pollinated with pollen from different inflorescences the same plant (d) gave approximately similar results. About 30 per cent of the flowers treated produced normal pods, 20 per cent produced imperfect pods, while 50 per cent were entirely sterile, and failed to develop at all. Consequently, it may be said that in *Pe-tsai,* different modes of pollination have no effect on fertility, when the pollen used is from the same plant.

Flowers pollinated with pollen from different plants (e) exhibited a very high degree of fertility—96 per cent of the pods being normal—which may be regarded as very near the actual

extreme degree of fruitfulness found in *Pe-tsai* under ordinary circumstances.

When the fertility of the flowers treated with pollen from the same plant (b, c, d) is compared with that of those treated with pollen from different plants (e), it is evident that the intensity of self-sterility, that is, the grade of infertility caused by selfing, is somewhat higher than 50 per cent.

Flowers bagged but not pollinated artificially (a), failed to fruit to a remarkable extent, giving only about five per cent of normal pods. This leads to the conclusion that the flowers of the *Pe-tsai* are so constructed that automatic self-pollination is almost impossible, because the selfed flowers in which pollination had been performed artificially (b), exhibited much higher fertility.

In addition, it should be mentioned that in the group in which the flowers were treated with pollen from the same plant, the individual variations in the grade of self-sterility exhibited a very wide range, all the way from complete fertility to complete sterility being observed. This suggests the possibility of strains occurring in which the percentage of self-sterility is inherently higher or lower than in others. Again, the fact was observed that in some individual plants pollination within a flower and that between different flowers on the same inflorescence was apparently less effective than that between different inflorescences on the same plant (Fig. 20), and so it is not improbable that strains exist which show important differences in regard to the extent of self-sterility. To clear up these points, however, it would be necessary to accumulate more data by further experiments.

Table I. *Effects of Artificial Pollination in Pe-tsai Cabbage.*

Source of Pollen Used	No. of plants treated	No. of flowers treated	Actual Number			Percentage		
			Normal pods	Imperfect pods	Failed to develop	Normal pods	Imperfect pods	Failed to develop
Flowers bagged (a)	12	167	8	11	148	4.8	6.6	88.0
Pollen from same flower (b)	32	423	128	71	224	30.3	16.8	53.0
Pollen from different flowers in the same inflorescence (c)	32	482	113	103	266	23.4	21.4	55.2
Pollen from different inflorescences of same plant (d)	27	331	117	75	139	35.3	22.7	42.0
Pollen from the same plant (b+c+d)	33	1,236	358	249	629	29.0	20.1	50.9
Pollen from a different plant (e)	2	25	24	0	1	96.0	0.0	4.0

DISCOVERY OF THE ANCESTRAL FORM OF DAHLIA JUAREZII

W. E. Safford

U. S. Department of Agriculture, Washington, D. C.

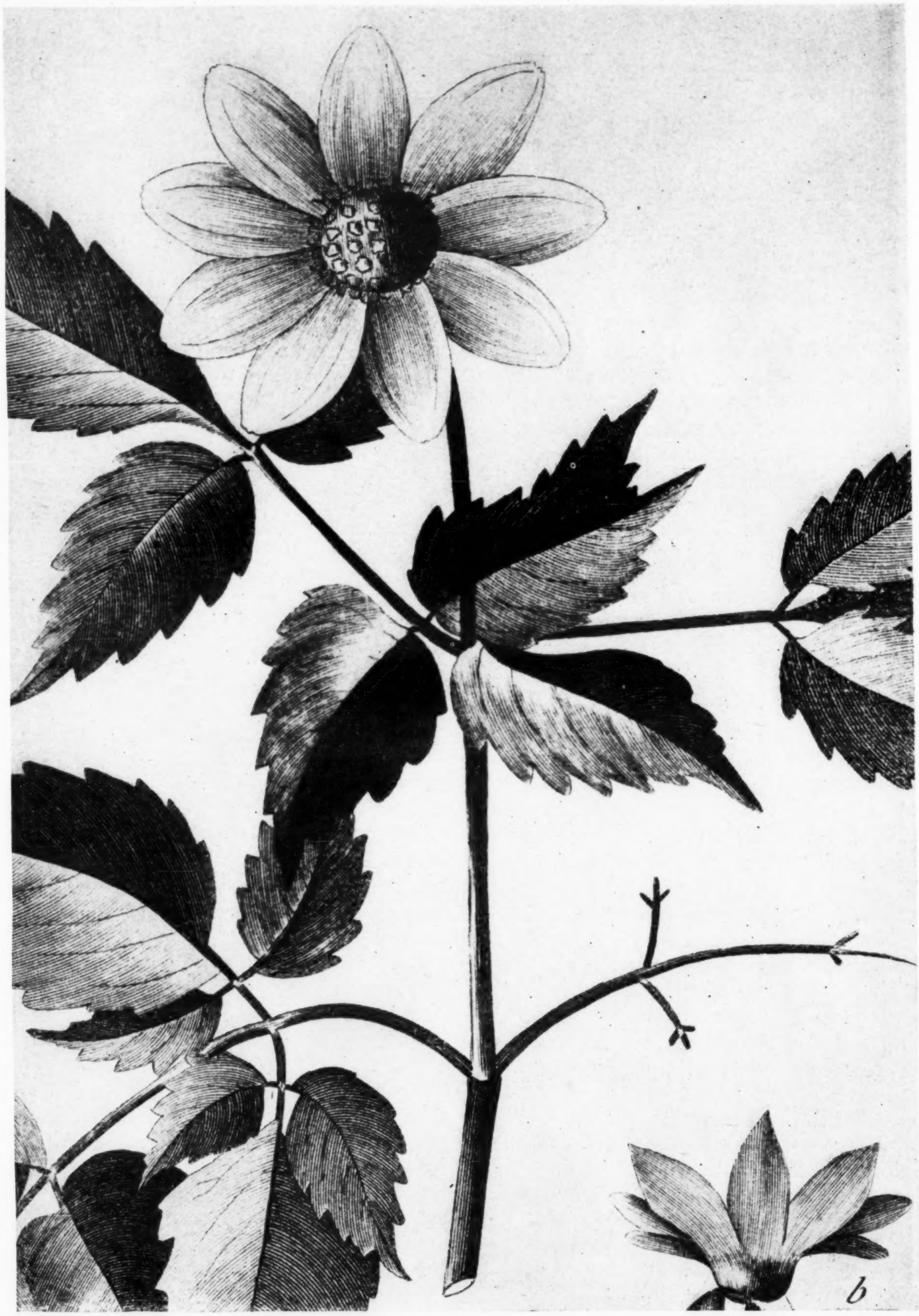
IT IS a well-established fact that we owe all of our beautiful *cactus dahlias* to a single plant, which was sent to Europe from some unknown locality in Mexico about the year 1863. It bloomed for the first time in 1864 and was figured in the *Gardeners' Chronicle* in 1879. By the cross-pollination of this plant with the types of dahlias previously cultivated, many beautiful forms resulted. From these have descended the varieties which we now call *cactus dahlias* and *hybrid cactus dahlias*, all of which are characterized by long florets, with their lateral margins turning backward instead of forward.

According to the accepted classification of (cactus) growers, *Dahlia juarezii* would be called a *hybrid cactus dahlia*. It resembled in all respects the variety called *Kalif* (Fig. 23). The ancestral wild form, with a single row composed of eight rays, remained unknown until October 21, 1916, when it was discovered by Wilson Popenoe, of the Office of Foreign Seed and Plant Introduction, while on a mission to Guatemala. This primitive species was described and figured by the writer in the *Journal* of the Washington Academy of Sciences, vol. ix, pp. 369 and 370, July 19, 1919. It was named *Dahlia popenovii*, in honor of its discoverer. Its long, spreading, crimson rays, revolute, or turning backward along their margins, can be compared with those of the well-known *Dahlia coccinea*, which is shown with it in the accompanying field photograph made by Mr. Popenoe near San Lucas, Department of Zacatepequez, Guatemala, October 21, 1916.

The specimen of *Dahlia coccinea* in Mr. Popenoe's photograph is an exact facsimile of the original type specimen figured by Cavanilles in 1794, except that it has eight instead of nine rays.

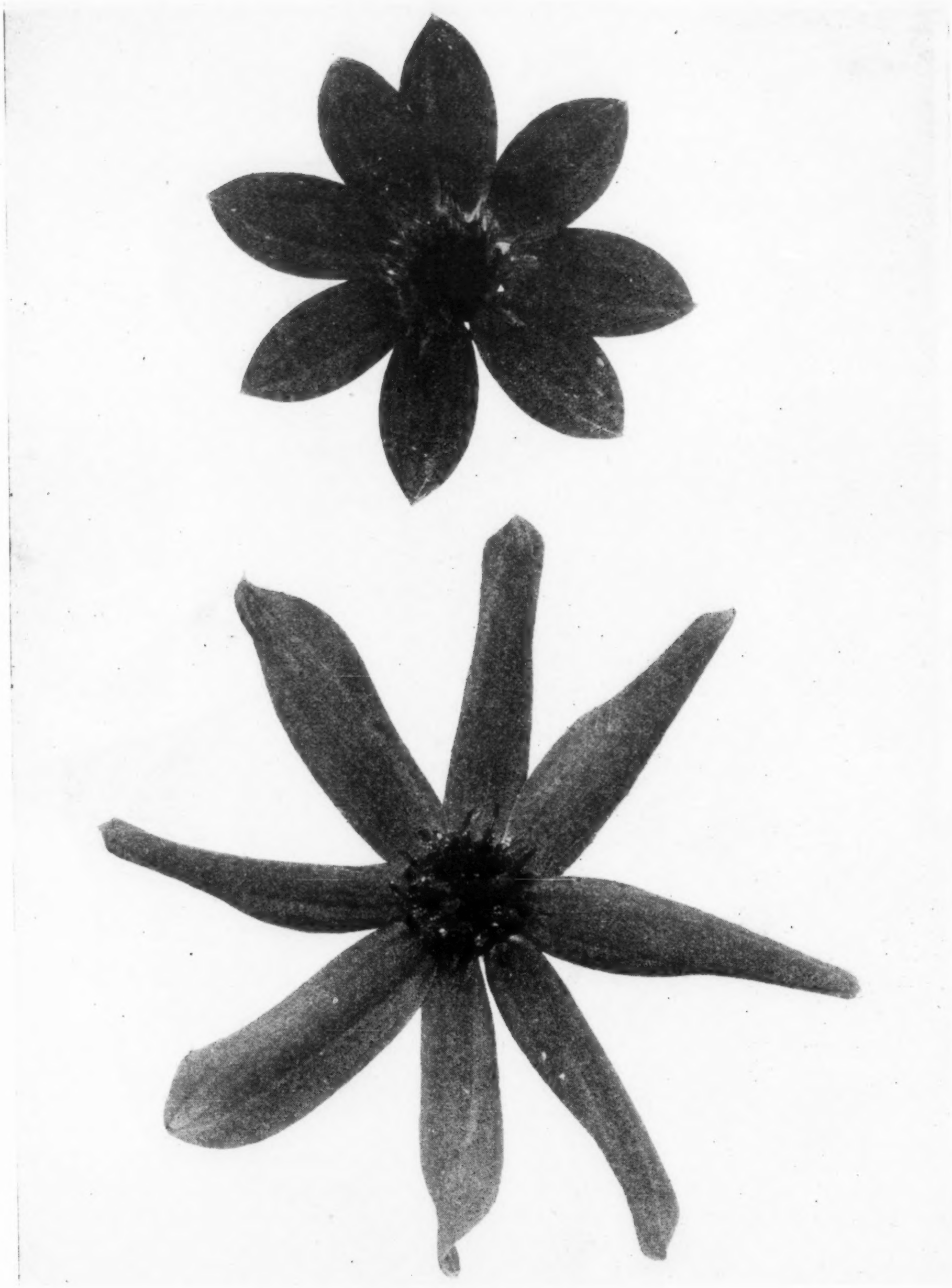
In Mr. Popenoe's notes, dated Antigua, Guatemala, October 23, 1916, is the following entry: "On my way back from Guatemala City to this place I collected some wild dahlias about two kilometers above Santa Lucia, at an approximate elevation of 6,600 feet, where the plants were most abundant. I have not seen them as low as 5,000 feet, but have found them up to 7,000, which is as high as I have gone. I do not know how much higher they may occur. The plants observed near Santa Lucia grow to a height of about four feet. The stem is a dull greenish purple to purplish green, usually glabrous but sometimes with scattering hairs toward the upper portion. Leaves twice-pinnate near the base of the stem, once-pinnate or simple above; leaflets of the lower leaves ovate acute, two and a half inches long, one and a half inch broad, remotely dentate, sparsely furnished with short bristly hairs, which are more scant beneath; rachis not exceeding five inches in length, often very short; petioles absent to three-fourths of an inch long. The flowers are two to three and a quarter inches broad, with eight-rayed florets, the latter sterile and orange brown or crimson in color, in some forms short and broad, in others long and narrow with the margins recurved or revolute, giving to the flower the appearance of a *cactus dahlia*, and contrasting with the other form having broadly spreading flat rays rounded at the tips."

Dahlia juarezii, the ancestor of all our *cactus dahlias*, like *Dahlia pinnata*, the type of the genus, was described from a hybrid plant growing in a state



DAHLIA COCCINEA

FIGURE 21. A reproduction of the figure published in 1794 by Cavanilles with his description of the species. It is nearly a replica of the wild Guatemalan form found by Mr. Popenoe, except that it has nine rays. Unlike *Dahlia juarezii* this species does not cross readily with other species and always comes true to seed, whereas *juarezii* is readily hybridized and is extremely variable.



WILD DAHLIA TYPES

FIGURE 22. These two flowers were collected by Mr. Popenoe near Antigua, Guatemala, in 1916. Above is shown *Dahlia coccinia,* remarkably like the specimen figured by Cavanilles in 1794 (see Fig. 21). The long-petalled, eight-rayed *Dahlia popenovii* is quite different from the "double" flower shown in Figure 23, which corresponds in form and color with the type of the species *juarezii,* the ancestor of our cactus dahlias. Contrary to the usual belief the Aztecs domesticated the wild dahlias found in the mountains of Mexico and Guatemala, and to them belongs the credit for originating the "double" forms.

PARENT TYPE OF THE CACTUS DAHLIA

FIGURE 23. All of our cactus dahlias trace back to a single plant sent to Europe from Mexico about 1863. This plant was also taken as the type of a new species of dahlia, *jaurezii,* but the simpler ancestral form remained unknown until the single, eight-rayed type shown in Figure 22 was discovered by Mr. Popenoe.

of cultivation. The flower-heads of both were "double," and both were ancestors of many varieties. So diverse were the seedlings of *Dahlia pinnata* that it was renamed *Dahlia variabilis;* but according to the rules of priority, its older name must be retained. For the same reason the name *Dahlia rosea,* also a synonym of *Dahlia pinnata,* must also be discarded. The many varieties of dahlias with rounded artificial-looking heads, formerly so common in gardens were all descendents of *Dahlia pinnata*. *Dahlia coccinea* offered a striking contrast to these in resisting all efforts of plant breeders to cross-pollinate it with them, and also in coming true to seed. Its heads are single; its color varies from scarlet to yellow or brownish red, never verging upon pink or crimson.

The idea has commonly prevailed for a long time that duplex and double forms were the result of recent cultivation; but it is quite certain that they were well known to the Aztecs, who domes-

ticated the wild dahlias of the mountains of Mexico and Guatemala before the discovery of America. Dr. Francisco Hernandez, the celebrated Protomedico of Philip II, sent by his sovereign in 1570 to New Spain to study its resources, figured three dahlias under the Aztec names *Acocotli, Cocoxochitl,* and *Acocoxochitl; cocotli,* like the familiar name *syringa,* signifying a hollow stem, or tube. These names may be translated "water-pipe" or "water-cane;" "cane-flower," or "hollow-stem flower;" and "water-pipe flower."[1] In the Madrid edition of his work (Vol. 1, p. 14, cap. 24) Hernandez describes a plant apparently identical with *Dahlia glabrata,* or *Dahlia merckii,* under the heading "De Acocoxochitl, seu flore Acocotli," with flower heads having yellow disks and purple ray-flowers. After which he goes on to say that many other forms of *Acocoxochitl* occur in Mexico, differing from one another in the size and color of the flowers, some of them white, others yellow, others purple or red, others white tinged with purple, or perhaps yellow tinged with red, and a great many other kinds, in some cases with double or multiple whorls or ray flowers, either forming circles or clustered in compact bunches (*manipuli*)."

[1] See SAFFORD, W. E. Notes on the Genus Dahlia, *Journ. Wash Acad. Sciences,* ix: 364. 1919.

Popular German Eugenics

HYGIENE DES GESCHLECHTSLEBENS, *by* DR. MAX VON GRUBER, pp. 116. Bucheri der Gesundheidtspflege Band 13, Stuttgart, Ernest Heinrich Moritz, 1922.

This popularly written little book by a well-known Bavarian eugenist has reached the astonishing circulation of more than 300,000 copies in Germany, and is now in its fiftieth printing. It begins with a brief but well written consideration of reproduction, heredity and selection, and the point of view of eugenics is that presented throughout the volume.—*P.P.*

A Psychological History of Mankind

ELEMENTS OF FOLK PSYCHOLOGY, by WILHELM WUNDT. Authorized translation by Edward Leroy Schaub, Ph. D., Professor of Psychology in Northwestern University. Revised Edition; pp. 52. New York, The Macmillan Co., 1921.

This book was first published in Germany in 1912. Professor Schaub's translation appeared in 1916. The extent of the revision is not stated.

Dr. Wundt's point of view is, of course, well known to all special students. This volume contains a great mass of material of interest to all who are concerned with the evolution of man. The almost total lack of reference to original sources deprives it of some of the value which it would otherwise have to the eugenist.—*P. P.*

EUGENICS IN GERMANY

THE German Society for Race Hygiene, founded in the same year (1905) as the American Genetic Association, has been generally recognized as the spokesman for a scientific view of the population problem in Germany. At its meeting in Munich last October, it issued a revised statement of its principles. This supersedes the "theses" adopted at the Jena meeting[1] in 1914, and special students will find it interesting to compare the two statements. In general it may be said that they show no radical points of difference, but an attempt has been made to produce a more comprehensive platform, in the new version.

The "Leitsatze der Deutschen Gesellschaft fur Rassen-hygiene" now stands as follows:

1. The chief danger to which every people is exposed is deterioration through the decrease of vigorous and useful racial elements.

2. A people can survive in the struggle for existence only if it comprises a large proportion of physically and mentally well-endowed men and women, of good character and morals.

3. The health, vitality, and cultural productivity of a population are not dependent on conditions of the environment (nourishment, education, infectious diseases, etc.) alone, but fundamentally also on inherited tendencies.

4. The heritable constitution of a people is not unchangeable. It can be turned in undesirable directions by two different methods: (a) through dysgenic selection, which leaves the more capable members of the population behind the less capable in respect of reproduction; (b) through direct injury to the germ-plasm, by racial poisons.

5. At present among civilized peoples a dysgenic selection actually exists to a very large extent.

6. The social ascent unfortunately brings with it, under present-day conditions, real danger of the dying-out of families.

7. The inadequate reproduction of those members of society who by hereditary endowment are best qualified for leadership is of the most ominous import to the future of the race.

8. The most important problem of race hygiene is therefore the preservation of socially valuable families in all classes of the community.

9. Inadequate reproduction is at present more frequently a result of deliberate birth-prevention, than of unwilled causes (venereal diseases, etc.).

10. Since not all children born attain the age of reproduction, the two-child system leads in a few generations to the disappearance of families. On the average, three children are scarcely sufficient to perpetuate the family.

11. The motives for birth-prevention are principally of a social and economic nature, and race-hygiene must therefore in the first place strive for social and economic reforms calculated to destroy or at least diminish the prejudice, among sound and capable married couples, against a sufficient number of children.

12. In tax legislation really adequate attention must be paid to the size of family. At the very least, each income and each estate must be divided (for purposes of taxation) into as many equal parts as there are members of a family.

13. From inheritance taxes families of three or more children should be entirely exempt, except in the case of excessively large estates.

[1] Printed in the *Journal of Heredity*, v: pp. 435-6, October, 1914.

14. A eugenic basis for inheritance taxation of rural real estate is particularly important. Otherwise it is to be feared that even the present landed families will no longer be able to have a sufficient number of children.

15. In the formation of farm colonies care must also be taken that the settlers are allowed to have or to expect an adequate progeny.

16. The encouragement of rural and suburban settlements is also of importance to race-hygiene.

17. A population policy directed toward a lower birth-rate, in accordance with neo-malthusian ideas, endangers eugenics, because it has been found that the decrease in births takes place especially among the most valuable families.

18. A purely quantitative population policy, on the other hand, which attempts to increase the number of births without taking account of the differences of inherited capacity, also tends toward decreased racial fitness, because all such measures lead especially to an increase in the birth-rate of the eugenically inferior.

19. The eugenic point of view should be given due consideration in all assistance extended to families having numerous children.

20. Special pay-allowances, based on the size of family, among government officials are only justified eugenically, if a sufficiently careful selection is employed in the appointment of these officials.

21. The family allowances should be considerably larger than hitherto, in proportion to the base-pay. At present, especially among higher officials, the child allowances remain much below the actual cost of bringing up children.

22. The best foundation of a people is an assured permanency of well-stratified families. The interest of the state therefore demands generous protection of the family.

23. All efforts tending to loosen the natural bonds that unite members of a family, especially those which lead to premature separation of mother and children, are to be combated as dangerous to the family and therefore to the nation.

24. For the perpetuation of our race, a union of as many capable families as possible from all strata of society, for the fostering of the eugenic attitude and for mutual aid, is desirable.

25. Delayed marriage in professions requiring lengthy preparation is eugenically unfavorable. The period of preparation should therefore be abbreviated as much as possible. In particular, a schooling of 12 or 13 years is too long. The members of every profession ought to be in a position to marry by the age of 25.

26. The eugenic bearing of the German marriage law, hitherto limited to the prohibition of marriage between the closest blood relatives and to the distribution of official blanks for publication of marriages, is inadequate.

A broadening of the marriage prohibition on eugenic grounds is to be hoped for in the future, but seems unattainable at present.

But without forbidding marriage, careful investigation of all applicants for marriage licenses is already practicable, and its legal introduction should be sought immediately.

27. The time seems not yet to have arrived among us for compulsory sterilization of the feebleminded and other defectives.

28. The sterilization of defective individuals by their own wish or with their consent should be regulated by law at once.

29. In order to prevent the reproduction of anti-social and other very defective individuals, their segregation in labor colonies, which can be made self-supporting by the work of the members, should at once be legally provided for.

30. The indiscriminate and widespread practice of abortion has an overwhelmingly dysgenic effect.

31. In order that the population may be intelligently advised on questions relating to reproduction, well-informed men and women ought to be appointed by the state as counselors on marital and family affairs.

32. Decision as to the permissibility of such matters as the termination of pregnancy ought to be reserved for special boards of investigation representing diverse professions whose information on the subject may be pertinent.

33. So long as prohibition of the consumption of beverages containing more than two per cent alcohol is not attainable among us, a system of cards, such as obtains in Sweden, ought to be introduced. Drinks containing less than two per cent alcohol should be freed from internal revenue tax.

34. To present measures for controlling venereal diseases should be added a system of confidential reporting, especially for syphilis, with compulsory treatment and provision for free treatment where necessary. A carefully guarded official register should be kept of all syphilitics, whereby their cure, and later fitness for marriage, can be determined better than hitherto.

35. The maintenance of a health register for the entire population, with investigations at appropriate intervals, should be introduced as soon as possible.

36. Better physical culture of our people will lessen the ignorance of all, even of the most cultured, as to the fitness or degeneration of the race.

37. We therefore urge the introduction of race-hygiene instruction in the high schools.

38. The older pupils in the higher elementary schools (middle schools) should have been already given a eugenic point of view, in connection with their general health teaching.

39. All candidates for the teaching profession should receive education in health, including race hygiene, and should have proved their understanding of it by passing an examination.

40. To further teaching and research in race hygiene, governmental institutions on the plan of the Swedish should be established.

41. The renovation of our whole outlook on life (*Weltanschauung*) is of decisive importance. The welfare of the family, even in distant generations, must be recognized in the vision of all as a higher good than mere personal comfort; and in governmental policies the needs of the present must not obscure the future of our race.

—*Paul Popenoe.*

The Physiology of Psychology

ELEMENTS OF SCIENTIFIC PSYCHOLOGY, *by* KNIGHT DUNLAP, Professor of Experimental Psychology in Johns Hopkins University. Pp. 368; price $3.50. St. Louis, C. V. Mosby Co., 1922.

Leaving behind the old introspective psychology, and avoiding some of the modern mystical schools, Professor Dunlap has presented the foundations of the subject largely from a physiological point of view. Little space is devoted to individual differences and other subjects in which genetics is particularly involved, but the brief mention given to heredity is well phrased.—*P.P.*

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